MINING CONGRESS JOURNAL

DECEMBER, 1958

WISHES YOU A

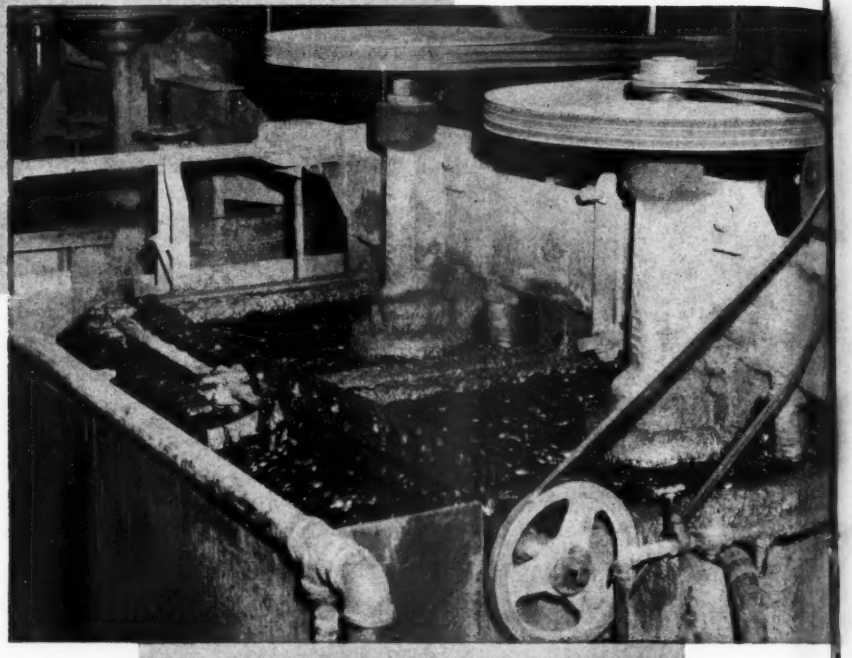
Merry Christmas

AND A

Happy New Year

DENVER TYPE "M" FLOTATION

Helps Improve Mill Metallurgy by 18% at IRON KING MILL of Shattuck Denn Mining Corp.



Installation of a 2-cell DENVER Type "M" Flotation Machine has played an important part in the increased metallurgical efficiency of the Shattuck Denn Iron King Mill at Humboldt, Arizona. On the basis of a metallurgical efficiency index established by Shattuck Denn 18% improvement has been attained during the past two years.

See For Yourself In Your Own Mill AT NO RISK What a DENVER Type "M" Flotation Machine Will Do For You

DENVER TYPE "M" FLOTATION

If you want added recovery take advantage of this opportunity!

Install a 2-cell DENVER Type "M" Flotation at the end of your present flotation circuit. If the DENVER Type "M" Flotation Machine fails to pay for itself by recovering minerals otherwise lost in tailings, return the machine to us and it will cost you nothing except the transportation and installation. The DENVER Type "M" is a self-contained unit ready to connect to your tailings line.

Please write or telephone us the details of your circuit so we can send you our recommendations without delay.

This offer must, of necessity, be limited. We urge you to act promptly. Our telephone number in Denver is CHerry 4-4466.

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Complete Mill Equipment

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CONTENTS

Opinions expressed by authors within these pages are their own and do not necessarily represent those of the American Mining Congress.

ARTICLES

Europe and the U. S. Coal Importation Issue — 30
Omer Anderson

Direct Reduction of Iron Ores in a Rotary Kiln — 34
Alex Stewart

Performance Standards for Continuous Mining — 39
D. C. Howe

Planning and Scheduling Maintenance — 42
J. A. Vitzthum

Haulage Developments at Enos — William C. Laidlaw — 45

Freezing for Shaft Sinking — 52
At PCA — Joseph B. Cummings and Russell G. Haworth (p. 52)
At IMC — Frank C. Pickard and Gilbert H. Duby (p. 53)

Modern Approach to Equipment Maintenance — 57
Ralph B. Dean

Impact of the Federal Road Program on the Mineral Industries — 59
C. D. Curtiss

An Operations Research Approach to Mine Haulage — Ernest Koenigsberg — 64

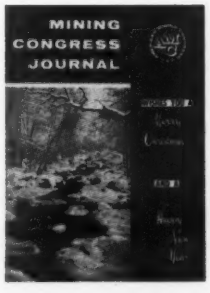
Discussion: An Operator's Views with O.R. — 65
Oscar D. McDaniel Jr.

DEPARTMENTS

Editorials — 29
Operator's Corner — 72
Wheels of Government — 74
Personals — 76
News and Views — 79
Manufacturers Forum — 92

ON OUR COVER

Merry Christmas and Happy New Year to all our readers! Whether you're having a white Christmas or not, we thought you'd enjoy Abbie Rowe's photograph of beautiful Rock Creek Park in Washington, D. C. — Courtesy of National Park Service.



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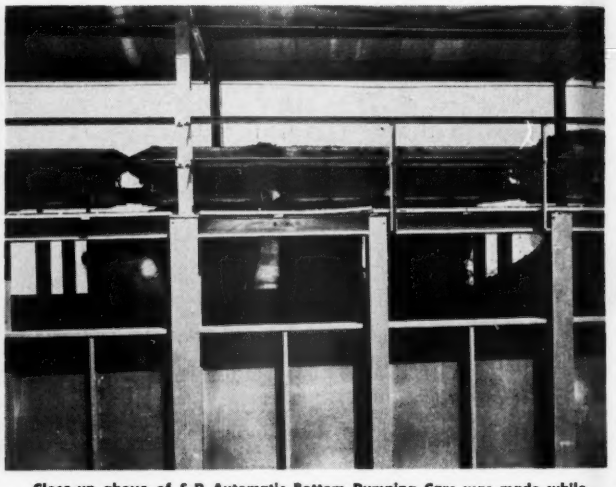
NOW - with S-D Automatic Overlapping End Cars...

Here is Automatic Loading and Dumping...

SOUTH-EAST COAL COMPANY'S Camp Branch, Ky., mine is an impressive example of alert, hustling management and operating personnel. Only a few machines and men are required for this simple, organized operation. Above you see the tipple and coal storage bin. Conveyor runs continuously hauling coal from bin to tipple. Bin provides surge capacity to permit successive dumping of long trips.

SLATE BIN is located a few hundred feet from Coal Storage Bin. The small bin in picture above provides track ballast. The same S-D Automatics that haul coal also haul out the top and bottom rock to Slate Bin. S-D "Automatic" Overlapping End Cars more than meet South-East's planned program for haulage at absolute minimum cost! Not only can a single trip of S-D Overlapping End Cars be loaded continuously and dumped one-after-another without stopping, but they provide maximum haulage safety! Automatic couplers eliminated accidents. Fingers, hands, arms, no longer have reason to be between cars, nor can a man get between cars after coupling!

Here you see trip of S-D Automatic Overlapping End Cars as it enters bin. Conveyor under track hauls coal from bin to tipple.

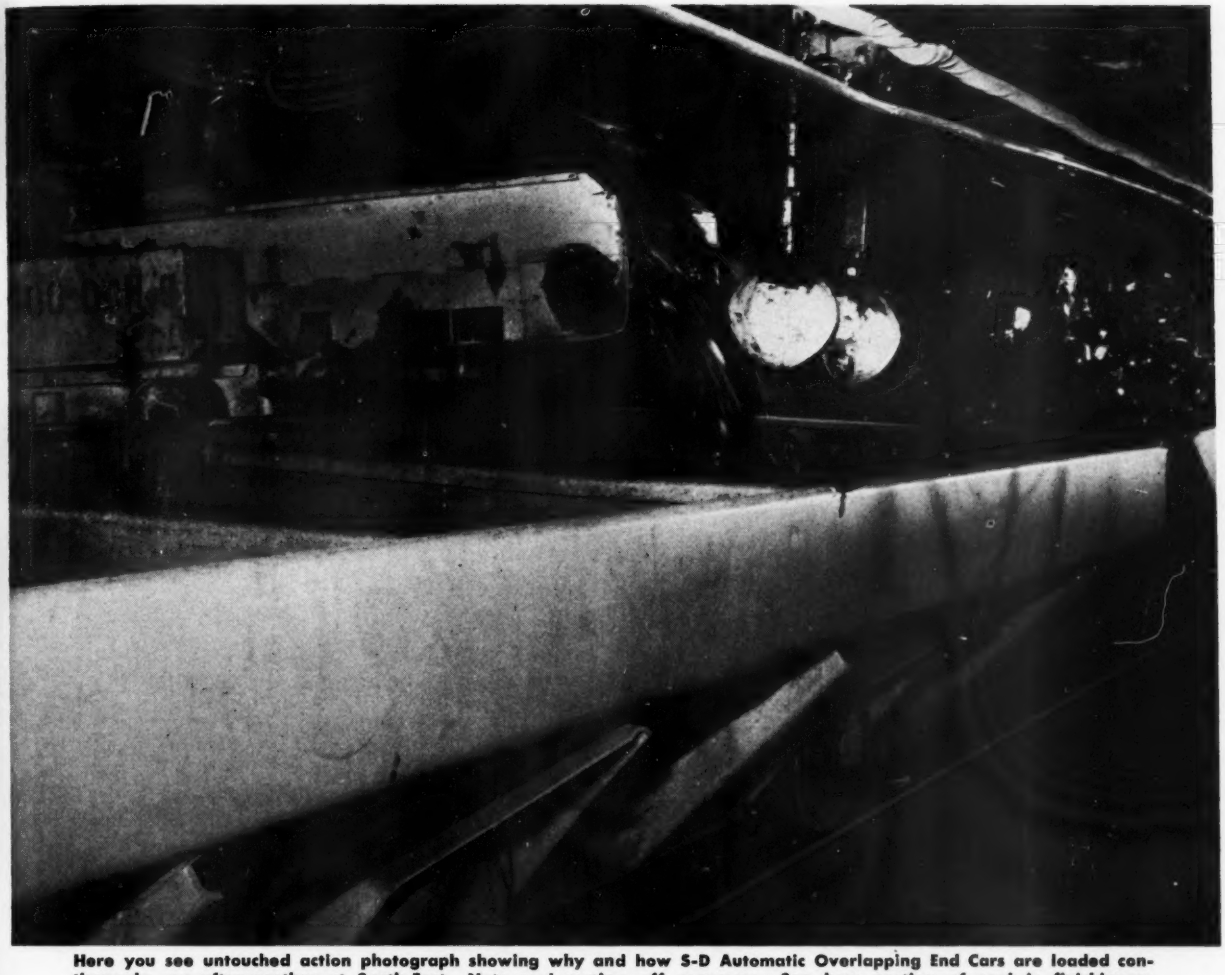


Close-up above of S-D Automatic Bottom Dumping Cars was made while trip was dumping. You can see bottom dumping doors actually down and the coal discharging.

TWENTY-NINE MEN, including Mr. Chester Cureton, day-shift foreman, pictured above, and Mr. T. B. Smith, night-shift foreman, operate one continuous miner two shifts at this mine. At present, operations consist of driving and grading a main line heading a distance of some 27,000 feet. In early 1960, additional sections will bring this mine to its designed capacity of 5,000 tons per day with no change in the basic haulage system.

This S-D Automatic Haulage System operates with minimum manpower requirements. The motor crew not only handles all haulage, but checks the performance of the manless automatic loading station. Clinton Fleming, above, is day-shift motorman. Earl Adams is motorman on night shift. These men are in charge of the system and make it tick like clockwork, leaving a trip of 10 to 16 empties to be loaded and hauling out a pre-loaded trip of 10 to 15 cars.

g...and Maximum Haulage Safety!



Here you see untouched action photograph showing why and how S-D Automatic Overlapping End Cars are loaded continuously one-after-another at South-East. Note coal coming off conveyor. See how portion of coal is finishing-up loading forward car while the other portion is starting to load empty car. (Trip was caught in movement while overlapping ends were directly under conveyor). Switches operated by ball movement activate hydraulic spotter which moves trip.

S-D "BROWNIE" Double-Rope Hoist moves railroad cars under loading chute at tipple.

SANFORD-DAY

KNOXVILLE, TENNESSEE

- S-D Mine Cars, all types and kinds.
- Precision S-D Mine Wheels.
- Tough, year-after-year wheel service by special S-D wheel Hard-Facing Process (this can really save you money and eliminate downtime).
- S-D "Brownie" Hoists. • S-D Car Spotters, all types, including special drop bottom car spotters.
- S-D Mine Sheaves and Rollers.
- S-D Automatic Loading Stations for Mine Car and Railroad Car Loading points.
- S-D Slusher-Trains for mining and construction industries.
- S-D Gismo and Transloaders for mining and construction industries.

This is an Actual Operation Picture-Report on the performance of S-D Automatic Overlapping End Cars. Savings provided by these cars are tremendous! One large mine recently converted its big Rotary Dump operation into a similar open track bin to realize the automatic-loading and automatic-dumping savings obtained only by S-D Automatic Overlapping End Cars. Every S-D Automatic Overlapping End Car installation is earning major savings! We have movies showing these cars, large and small, in regular mine haulage. May we show them to you? Write us today.

SANFORD-DAY IRON WORKS, INC., KNOXVILLE, TENN.

US RUBBER SEARLE SLEEVES

The patented proven way to prolong conveyor belt life!

The patented Searle Sleeves are made of abrasion-resistant cushion rubber reinforced by heavy belt duck. Installation is fast, just slip them over the idler rolls. At impact points, cementing is recommended.

The build-up of wet muck in coal mining and fines and dust in metal mining are minimized or completely prevented on belts when idlers are equipped with U.S. Searle Sleeves. These Sleeves protect idler rolls from impact damage at transfer points. Keeping idlers clean and free from build-up eliminates constant servicing, and at the same time insures longer belt life. Belt "wandering" is eliminated and edgewear greatly reduced on both belt and idlers.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Close-up of U. S. Searle Sleeve. Available in large variety of sizes to fit conventional conveyor idlers.

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United States Rubber

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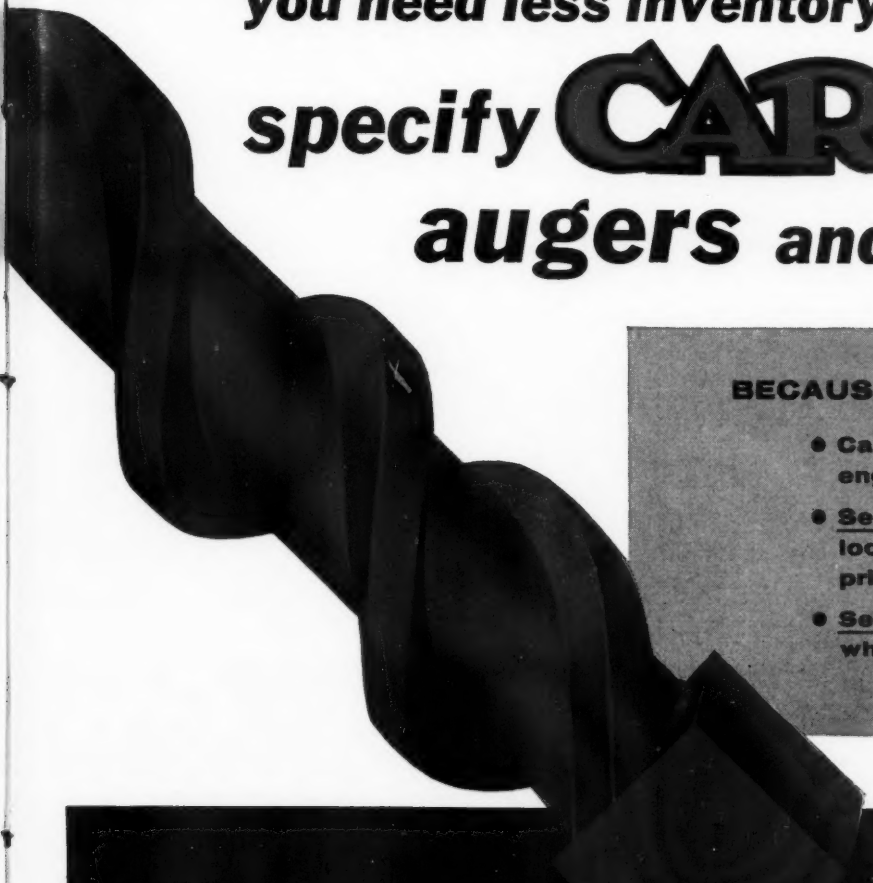
you need less inventory when you specify CARDOX augers and bits . . .



BECAUSE:

- **Cardox augers and bits are engineered for longer life**
- **Serviced from conveniently located warehouses in principal mining areas**
- **Serviced by mining-men who know your problems**

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ALLOY-STEEL ROOF AUGER

gives you 2 to 1 performance over others

Toughest ever . . . Cardox roof augers last longer! Constructed of tough alloy-steel, welded – then heat-treated for added strength and abrasion resistance. An added pitch of flight at the shank end gives added strength at the point of stress. Your costs go down with Cardox roof augers on the job. Available in standard lengths from 10" on up.

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Sizes: 1⅜" to 1⅞"

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Sizes: 1⅝" to 3"

Continuous Miner & Cutting Machine Bits

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Rely on Cardox for quality carbide tipped-tools. Complete stocks at conveniently located warehouses permit delivery within a matter of hours when required.

Rely on Cardox for practical answers to all your drilling problems. Our Field Engineers are qualified underground mining-men with the experience and know-how to answer your needs efficiently, effectively and economically.

Call on us . . . where there's coal, there's CARDOX!

CARDOX CORPORATION

DIVISIONS:

FIRE . . . carbon dioxide and foam fire extinguishing systems, equipment and trucks

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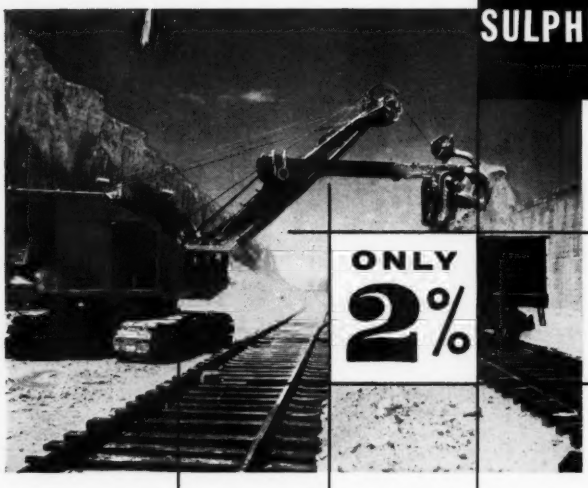
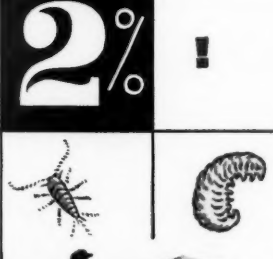
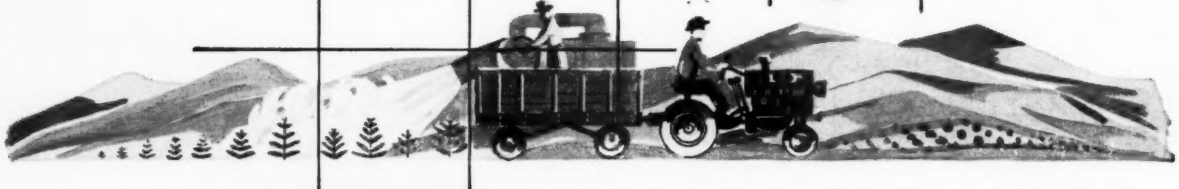
SULPHUR

ONE OF THE FOUR
STRONG PILLARS
OF PROCESSING



...BUT WHAT A 2% !





A recently compiled breakdown of Sulphur consumption in the United States, shows about 2% of the Sulphur goes into the manufacture of insecticides and fungicides.

Not much, perhaps, as tonnages go but no other use of Sulphur is more important with the possible exception of the 'wonder' drugs. It doesn't take much imagination to picture what would happen if the bugs and parasites were allowed to take over our crops and trees. Sulphur, along with other chemicals, is helping to protect our food supplies and foliage.

The role that TGS is playing in this constant fight against crop destruction is to see to it that the manufacturers of the insecticides and fungicides *always* have a ready supply of Sulphur, both solid and molten. This constant production and centralized distribution coupled with technical help is our contribution to industry.

SULPHUR PRODUCING UNITS

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Use same L-W prime-mover in stripping and hauling

You save on original equipment investment . . . and reduce operating costs

Stripping overburden is different from mining out pay ore or rock. It is basically a *scraper* job—can be handled most economically by modern scrapers. They leave your shovels and haulers free to maintain steady production.

Yet, since stripping is not a continuous operation in most pits, you need a multi-purpose machine—one that can quickly switch over to hauling shovel-loaded material when you catch up on stripping of overburden.

You get this advantage with the LeTourneau-Westinghouse Tournapull® line. These L-W machines keep equipment investment and operating costs low *all year long* because of their interchangeability feature (see panel). The prime-mover—major part of your original machine investment—interchanges with a variety of profit-making work trailers for other specialized duties. They handle your stripping, land-leveling, roadbuilding, pit-hauling, and waste product disposal efficiently, and at low cost.

Cut costs on your operation

The next time you consider investing in new stripping or hauling machinery, investigate Tournapull. Ask about the multiple work bonus you get (at fractional cost) from its interchangeable L-W trail units. Ask for specifications and prices on all 3 sizes. All have road speeds of close to 30 mph, ability to turn 180° non-stop in less than their own length.

L-W Tournapull Scrapers in 3 Sizes

Size	Diesel HP	Maximum MPH	Bowl Yards	Capacity Tons
B	335*-325	30.0	28	32.5
C	210	29.9	18	20.0
D	138	29.5	9	10.0

*when torque converter is specified

P-1860-MQ-1

Interchangeable Rear-Dump

Tournapull scrapers interchange with other L-W trailing units behind the same prime-mover. For pit work, the Rear-Dump offers economical hauling ability, and simple operation — plus all the advantages of Tournapull speed and mobility. Bowl capacities are 35, 22, and 11 tons. Other L-W trailing units, suitable for pit and quarry work, include bottom-dump and side-dump haulers.

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

NEW CP ROOF BOLTING UNIT

Completes entire bolting cycle—on the double!

Less than 3 minutes! That's all it takes the new RBD-30-579 to complete an entire roof bolting cycle from hole drilling to bolt setting. (Where hole depth is less than 36″, the entire cycle can be completed in 1½ minutes.) *New* stepped-up motor HP gives it 30% more power . . . *New* 40% increase in gear strength means beefed-up capacity in auger and bolt setter gear train . . . *New* built-in cooling fan yanks heat away from enclosed motor, adding life to insulation. Furnished with low speed spindle adapter for slow speed drilling plus low seam drilling attachment for low coal. *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, New York.*

Chicago Pneumatic *8 East 44th Street, New York 17, N. Y.*

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Cut mining costs thru better clean-up

There are only two ways to increase your mining profits without a rise in the price of ore. You must increase your production, or lower your operating costs . . . or both.

Here are 9 big ways a versatile modern high-speed grader can increase mining production and cut operating costs, to boost your profits.

1. Regular, more frequent maintenance of haul roads — Smooth roads speed hauling, save tire-wear, cut maintenance, improve safety.

2. Quick clean-up after blast — Grader provides a fast, inexpensive way to move scattered fragments back against toe, thus protecting tires, machinery, and men working around the pit . . . speeding up all pit operations.

3. Clean pit floors — Regular routine in maintenance of wide traffic ways makes all areas of the pit quickly accessible. Equipment can travel to any assignment by the shortest route. Smooth access pays off, saves wear on tires and crawlers, improves drainage, prevents dirt and refuse from weathering into levels of ore below pit floor.

4. Maintain good housekeeping around plant — You need ample grader capacity to keep roads, runways, working areas around plant neat, clean and workable at all times. Level or remove the occasional spill left by heaped trucks . . . from around hoppers, grizzlies, conveyors, and trestles. A clean plant area speeds all mobile equipment operation around plant, reduces dust, and improves safety.

5. Keep stockpile toes pushed in — Weather and loading operations result in spread of toes around stockpile. This limits working space, wastes stored material. Also, working thinly-spread toes means inferior ore grades, increased loading cost. Regular grader service helps prevent this waste.

6. Keep dumps smoothly spread and level — A level, dry dump speeds hauling, cuts equipment costs. Graders can spread dumped material clear over edge. Offset blade reaches far beyond leaning front wheels, which hold against side thrust. Grader can smooth haul road on the way to and from dump.

7. Clean ore benches of washed-down dirt — Every rain washes dirt into upper benches, lowers ore grade. Prompt grader service halts "wash", provides planned drainage, piles washed-in material for easy removal by scraper or truck.

8. Assist exploration teams — A modern grader can build a well-graded roadway in a matter of hours, can speed exploration work by maintaining good haul roads.

9. Keep drainage open — In a few hours per week, a modern grader will keep ditches clean, pit dry.

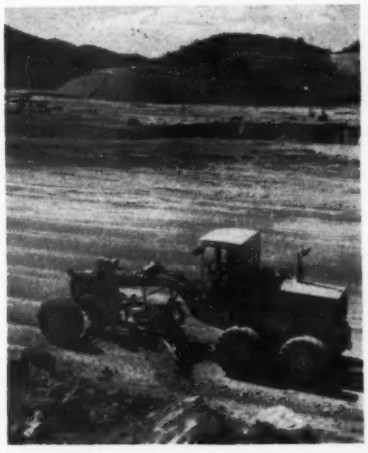
Inventory capacity of your present graders

It will pay you to inventory the work capacity of your present graders. If they are more than a few years old, you will probably find a substantial saving in replacement with the faster, more powerful, big-capacity graders currently on the market. We will be glad to assist by furnishing specifications and comparative statistics on our L-W line of modern Adams* graders, manufactured by the LeTourneau-Westinghouse Company.

Reprints available on request.

Moving fast, this L-W model 660 Adams grader keeps pit floor clean, saving wear on fleets' tires and treads. Permits driving equipment by shortest routes, improves drainage.

This high-speed modern grader keeps haul roads in good condition to speed movement of haulers, reduce wear on tires and machines.



Occasional spill over sides of heaped trucks . . . around hoppers, grizzlies, conveyors, and trestles . . . can litter concentrating plant area, slow traffic, damage tires. Regular grader service speeds operations, saves on maintenance and repairs. *Trademark G-1812-M-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

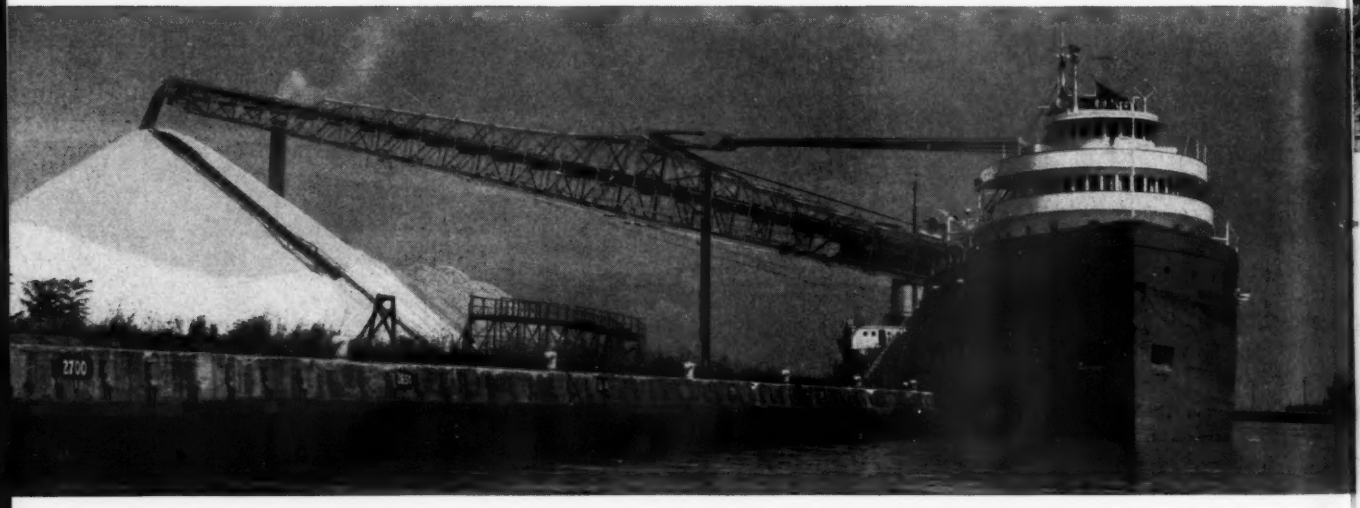
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

No belt weaving

Close-up of Type II LORIG-ALIGNER Self-Centering ROLL in action under maximum load.

USS LORIG-ALIGNER Self-Centering ROLLS keep belt centered at 625 fpm while conveyor unloads 5000 tons per hour



WHEN Michigan Limestone's steamer *Myron C. Taylor* hauls into port with a cargo of 14,000 tons of limestone, even the old dock hands amble over to watch her start unloading. A 250′ boom swings out from above the hold and in a few minutes the *Taylor* spews out her cargo at a rate as high as 5000 tons an hour. The limestone shoots out along the conveyor belt at 625 feet per minute —the entire load is piled on shore in record time.

Even at this speed, positive control of belt-tracking is assured because the head and tail pulley positions are equipped with Type II, slit, rubber-covered, LORIG-ALIGNER Self-Centering ROLLS. These rolls, with their built-in centering action, provide accurate travel, even under adverse load conditions, and there's no fouling of the belt on the conveyor structure. Additional advantages were also gained by employing LORIG-ALIGNER ROLLS for the drive and tensioning pulleys. The slitting of the rubber covering also increases the friction between the roll and belt, thus reducing belt wear and better utilizing the drive roll energy.

If you have similiar tracking problems, the patented self-centering feature can easily be adapted to pulleys now in use. This is accomplished by the application of a rubber covering on such pulleys and slitting according to the self-centering principles. This service can be supplied by the Licensees listed below.

USS and LORIG-ALIGNER are registered trademarks

TYPE II LORIG-ALIGNER ROLL LICENSEES

AUTOMOTIVE RUBBER COMPANY, INC., Detroit 39, Michigan

SAMUEL BINGHAM'S SON MFG. COMPANY, Chicago, Illinois

CHICAGO RUBBER COMPANY, INC., Waukegan, Illinois

THE DAYTON RUBBER COMPANY, Dayton 1, Ohio

DENMAN RUBBER MFG. COMPANY, Warren, Ohio

B. F. GOODRICH COMPANY, Akron, Ohio

GOODYEAR RUBBER COMPANY, San Francisco 7, California

GOODYEAR TIRE & RUBBER COMPANY, Akron, Ohio

IDEAL ROLLER & MFG. COMPANY, Chicago 8, Illinois

THE MORELAND CORPORATION, Willow Grove, Pennsylvania

THE NAZAR RUBBER COMPANY, Toledo 7, Ohio

OLIVER TIRE AND RUBBER COMPANY, Oakland 8, California

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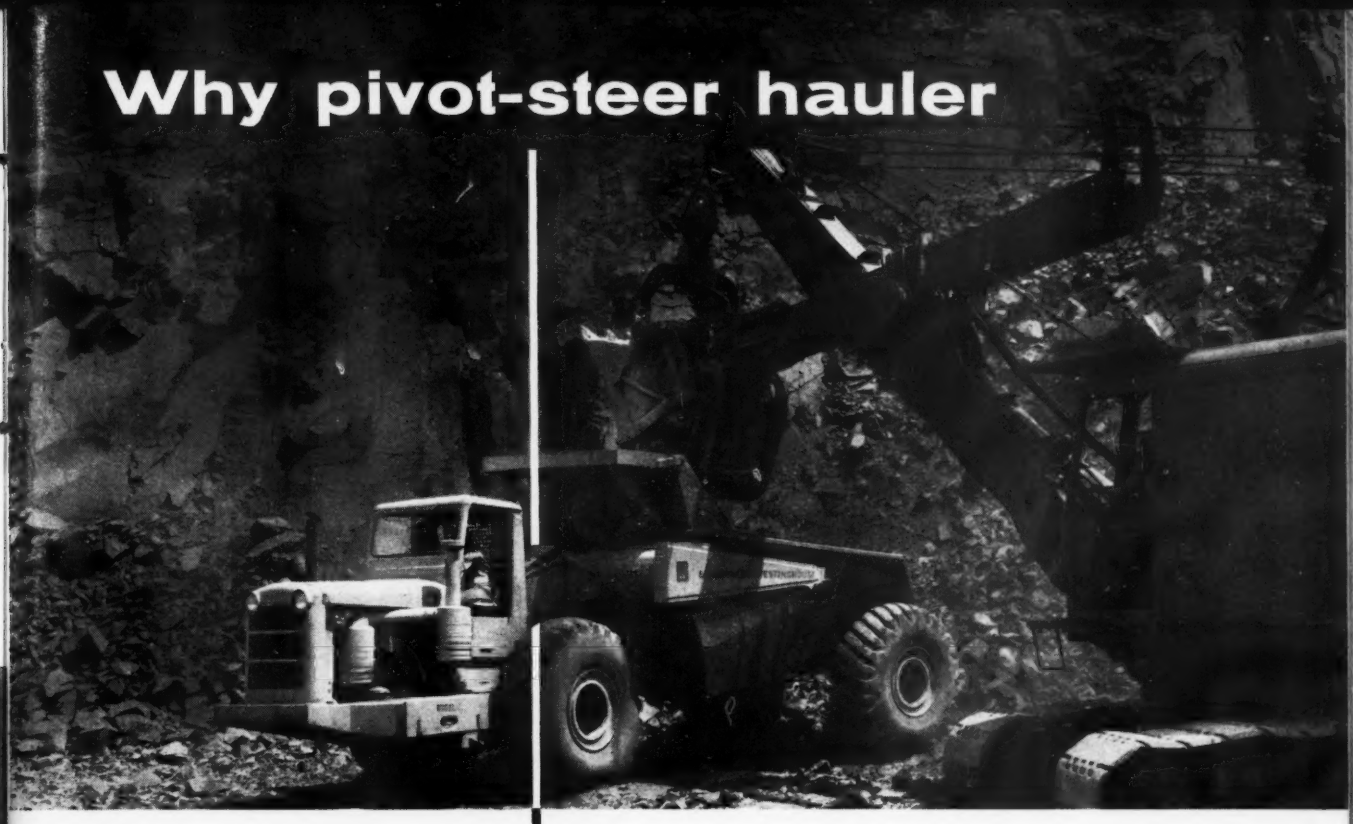
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

USS

United States Steel

Why pivot-steer hauler



cuts equipment downtime... boosts pit output... lowers handling costs...

Rugged, simplified construction is one big reason why speedy LeTourneau-Westinghouse Tournapull® Rear-Dumps keep working efficiently day after day... year after year... to help pit owners cut costs. Notice that on this machine there are no springs, no tie rods, no hose and pipe lines, no frame, no long drive-shaft to require maintenance and repair.

In place of a foundation frame and body sub-frame, Tournapull prime-mover and trail-unit are hitched together by means of a high horizontal yoke. Yoke pivots horizontally on kingpin at front... then extends back along side of bowl, where it pivots vertically just above and ahead of rear wheels. This unique vertical and horizontal kingpin arrangement also provides an easy oscillating action that eliminates most twisting, tilting strains ...permits higher working speeds on uneven ground to boost pit output.

Resists heaviest loading jolts

Shovel operator does not have to take it slow and easy when loading heavy materials. L-W Rear-Dump bowl is all steel — no wood fillers. Triple-layer floor is lined with heat-treated tool-steel strips, welded to solid billets laid over heavy steel plate. Sloping sides deflect load shock, quickly cushion floor area with layer of material to minimize rock damage.

Tire, clutch, transmission wear reduced

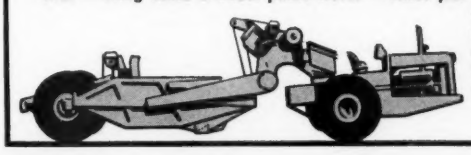
Costly wear on tires, clutch, and transmission caused by spinning wheels in slippery or loose footing, is minimized with Tournapull Rear-Dump. When either powered wheel begins to spin, unit's exclusive L-W power-transfer differential automatically diverts up to 80% of power to drive wheel on firmest footing. Also, electric 90° pivot-turn through geared kingpin, lets operator "walk" prime-mover out of mud or loose sand. Dumping action can also be used to "hump" empty hauler off a soft bank.

Features like these — plus full 90° turns, efficient electric-controls, fast, clean dump, giant air brakes, excellent visibility — add up to high production and low costs. Let us show you a LeTourneau-Westinghouse Tournapull Rear-Dump in action. Available in 3 sizes: 11, 22, and 35 tons.

R-1892-MQ-1

Bonus interchangeability feature

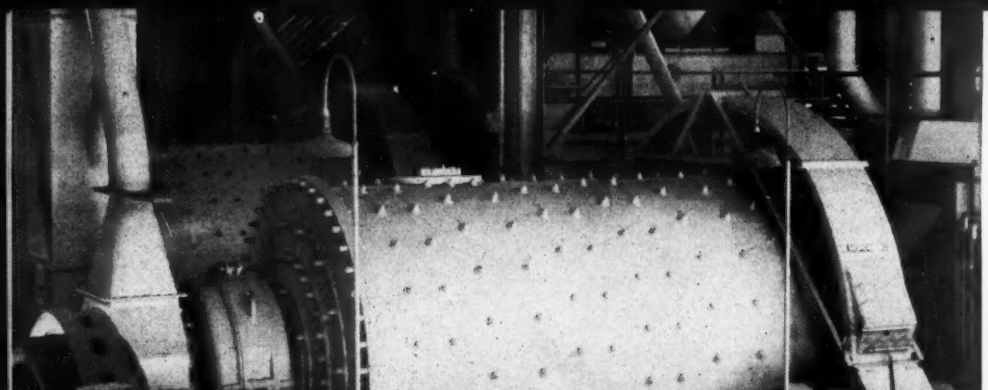
For less than ¼ the cost of an L-W Tournapull prime-mover with Rear-Dump, you can get an easy-loading L-W scraper to interchange with original Rear-Dump trail-unit. Change-over — using same 2-wheel prime-mover — takes just a few hours. Use scraper to lower dirtmoving costs on stripping operations, haul-road or drainage construction, and for exploratory mining. Other trail-units to increase prime-mover's usefulness also available.



LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

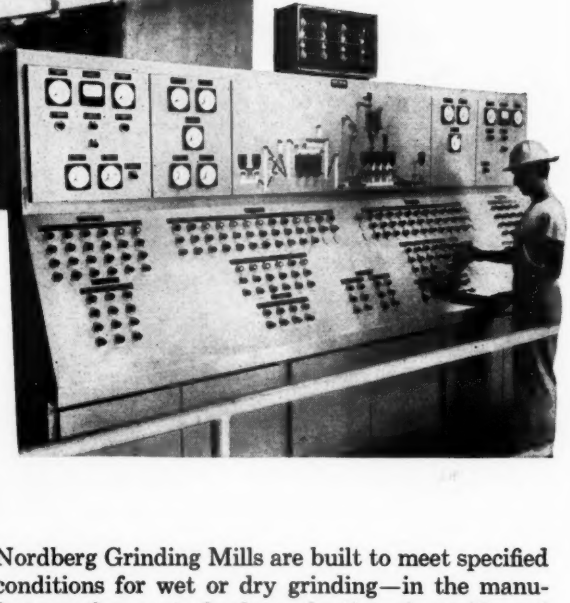
A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit



Left: Two of five 11' x 17' Nordberg Grinding Mills installed for dry process service at a new cement plant.

Below: Close-up view showing modern, functional Nordberg grinding mill control console, with interlocking relays for sequence starting of all equipment. Note flow diagram with indicator lights at center of top panel.



3 reasons why it pays to specify NORDBERG GRINDING MILLS

1 Advanced Engineering Nordberg mill design reflects significant technological improvements that may measurably affect your installation and operating costs. Sealed trunnion bearings; positive bearing lubrication; optimum life of wearing parts are among the features that will benefit you.

2 Quality Manufacture Nordberg Mills are (1) precision built to rigid specifications in shops renowned for (2) skilled manufacturing personnel, and (3) modern machine tools and equipment to assure quality workmanship. Good reason why the name NORDBERG has always signified the *ultimate* in mining, quarrying and process machinery.

3 Dependable Operation A team of experienced application engineers with a sound understanding of your milling operations qualifies Nordberg to serve you. More important, it assures you of the right machinery for the job . . . machinery that must be dependable and will continually produce to your specifications.

Nordberg Grinding Mills are built to meet specified conditions for wet or dry grinding—in the manufacture of cement; the fine reduction of metallic and non-metallic minerals; and in numerous other processes where friable material must be comminuted to fine sizes at low cost per ton. They are available with grate, overflow or peripheral discharge . . . and are built in sizes from 6 feet to 13 feet in diameter and up to 50 feet in length.

Write for a copy of Bulletin 232, which describes the complete line of Nordberg Grinding Mills.

NORDBERG MFG. CO., Milwaukee 1, Wisconsin

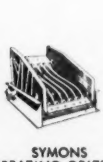
©1958, N. M. Co.

CP258

NORDBERG

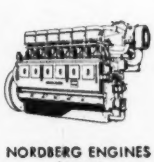
ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY
MINNEAPOLIS • NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO
TAMPA • WASHINGTON • TORONTO • VANCOUVER • GENEVA
JOHANNESBURG • LONDON • MEXICO, D.F.

SYMONS® CONE CRUSHERS



SYMONS VIBRATING GRIZZLIES and SCREENS

ROTARY KILNS and COOLERS



NORDBERG ENGINES to over 11,000 H.P.

New, low-cost way to improve haul roads

There is new emphasis, these days, on road-maintenance in mines and quarries. Many pits now use blading equipment full-time on haul routes. Others are hard-surfacing their roads. Reason: auto and tire makers have proved that maintenance costs far less than slow hauling, excess tire wear, and equipment breakdowns caused by poor roads. Good haul surfaces boost production, lower equipment up-keep costs.

You can keep haul roads smooth, fast, safe, *at rock-bottom cost*... with no "extra" equipment, no more man-hours than you're now paying for, and no new personnel. Next time you replace a crawler-tractor, replace it with *rubber-tired* Tournatractor®. This LeTourneau-Westinghouse machine will handle all the work of the rig you trade in, and, because of its extra speed, take on a regular road-maintenance program as a "bonus" service.

Instant-shift, positive brakes, and electric blade control, plus speeds to 17.2 mph, make Tournatractor a fast worker. It's rugged, too. And, in a few minutes, it can leave its regular assignment and run, at 17.2 mph, to dig a drainage ditch, smooth a rutted road, clean silt off a bench, tidy up a stockpile, or do other tractor work. This "extra" service costs you nothing in added investment, operating cost or added personnel.

Move it anywhere . . . profitably

Key to this "double duty" ability is the fact that, unlike crawlers, Tournatractor is not "tied down" to one location, or one job, in your pit. Because it travels at 17.2 mph, you can move it around at will . . . easily, quickly, efficiently. Tournatractor can often leave its "regular" job, get to any part of your road system in a few minutes, do a quick maintenance job, and return to its normal assignments before it is missed.

Trying the same plan with a track-rig rarely works. First of all, you seldom can spare the time a crawler needs to get anywhere. And if you *do* have time, the 5-to-6 mph crawler spends most of it just traveling. Also, scheduling a crawler on a 4 or 5 mile per day travel circuit costs plenty in track wear and repairs.

Time for roadwork easy to find

Finding time for Tournatractor's roadwork is easy. This high-speed unit can clean up at several shovels, still find time to do roadwork — plus other plant and stockpile clean-up — in-between clean-up sessions along the working face. Many pits have found that just one Tournatractor can replace two or three crawlers and handle *all* "miscellaneous" grading and pulling jobs as well as shovel clean-up.

For all its mobility and speed, Tournatractor is a hard worker, too. Massively, ruggedly built, it offers 210 hp . . . delivered through an anti-friction drive and torque converter to four, wide, low-pressure tires . . . for positive traction on any surface.

Let us send you complete details on how "go anywhere" Tournatractor can easily handle road maintenance in your pit at no extra cost.

CT-1647-MQ-1

LeTOURNEAU-WESTINGHOUSE COMPANY, PEORIA, ILLINOIS

A Subsidiary of Westinghouse Air Brake Company

Where quality is a habit

CF&I Expansion Type Rock Bolt—with Pattin Type D-1 expansion shell . . . for 1⅜" holes . . . with right or left hand threads (to allow tightening by left-hand rotation of drilling machines). Also available, the Pattin D-5 shell for use with ¾" and ⅞" bolts in holes of 1⅜" diameter . . . and CF&I Slot-And-Wedge Type Rock Bolts.

stronger, safer, space-saving support... AT LESS COST

strength—when anchored in mine roofs or walls, CF&I Rock Bolts provide maximum resistance to load with a minimum of displacement. Pattin expansion shells double the usual shell expansion, grip twice as hard.

safety—high strength steel, (to American Standard Specifications for Roof Bolting Materials sponsored by American Mining Congress), provides ample factor of safety...fully safety-tested...proven in use throughout widespread applications...CF&I Rock Bolts eliminate the danger of timbers bending or buckling under load.

space-saving—cumbersome, space-consuming timbering methods may be unnecessary. CF&I Rock Bolts permit maximum utilization of available work space and ventilation facilities.

cost-saving—less bulky, easier to haul and install than heavy timbers. When used with Realock Metallic Fabric for lagging, CF&I Rock Bolts offer proved initial-cost savings up to 35% over timber sets.

OTHER CF&I PRODUCTS FOR THE MINING INDUSTRY

CF&I Grinding Balls • CF&I Grinding Rods • Wickwire Rope • Mine Rail and Accessories • CF&I Industrial Screens • Realock Metallic Fabric

ALSO, for your convenience, CF&I SLUSHER PINS

When you make your own slusher pins, the cost may be high and you may not get the best possible results. As a customer service, CF&I makes available Slusher Pins made to the same high standards of quality, performance and minimum cost as our Expansion Type Rock Bolts. Modified CF&I Rock Bolts also make excellent hangers for such equipment as air and water pipe, electrical cable, vent tubes and ventilating fans.

CF&I Slusher Pin—consisting of a ¾" bolt threaded at one end, and a 2¾" I.D. eye formed and welded on the other end. These are anchored in 1⅜" diameter holes by means of Pattin Type D-1 expansion shells, and successfully withstand the pull from slusher drums.

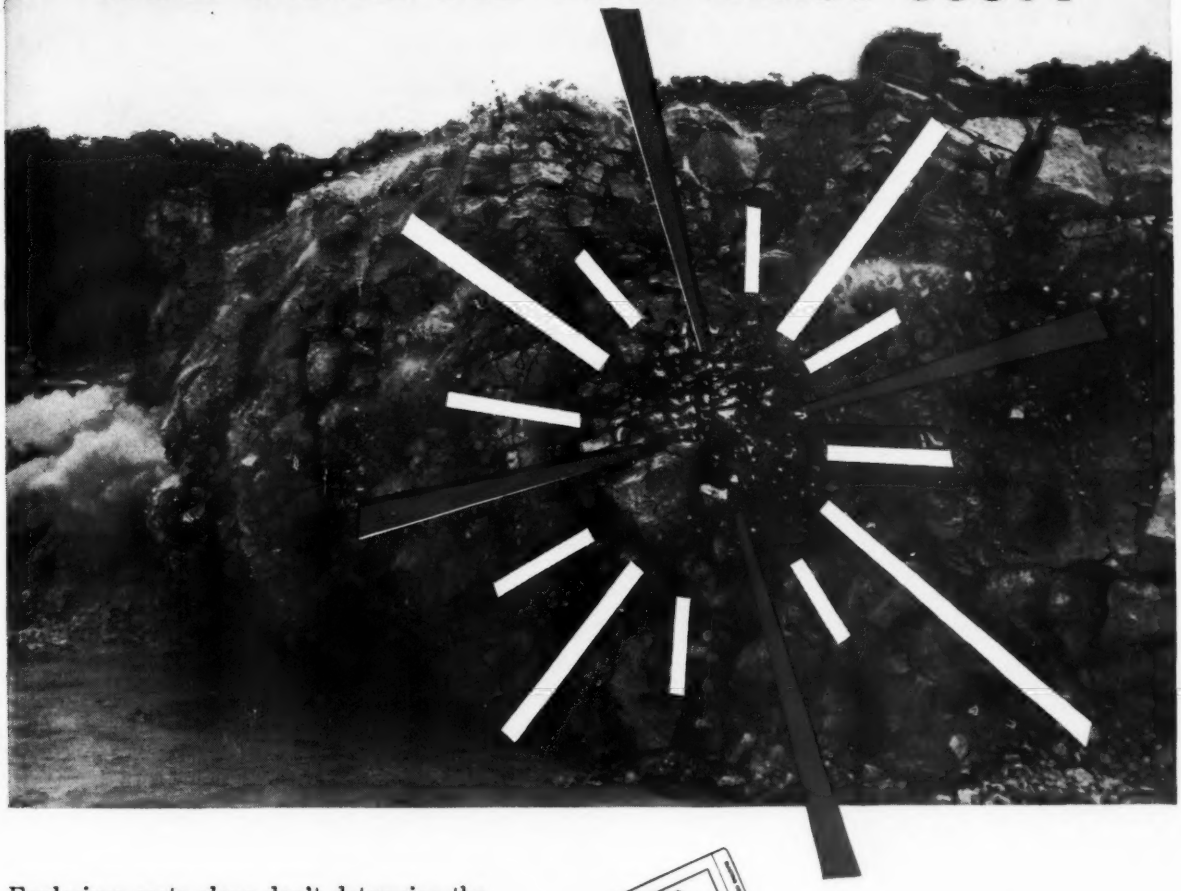
A 20-min. Rock Bolting color movie "Make Mine Safety" is available for showing, through the offices listed below.

THE COLORADO FUEL AND IRON CORPORATION

Albuquerque • Amarillo • Billings • Boise • Butte • Chicago • Denver • El Paso • Ft. Worth • Grand Junction • Houston
Kansas City • Lincoln • Los Angeles • New Orleans • Oklahoma City • Oakland • Phoenix • Portland • Pueblo
Salt Lake City • San Antonio • San Francisco • San Leandro • Seattle • Spokane • Wichita
CANADIAN REPRESENTATIVES AT: Calgary • Edmonton • Vancouver • Winnipeg

6276

HOW MUCH DID THIS BLAST COST?



Explosives costs alone don't determine the value of a given blast. The explosives you use have a direct effect on the whole operation: drilling, digging, hauling and crushing.

You can find out, quickly and easily, the true, complete cost on any blast by using the new, simplified computing method developed by Atlas. It's called the Blasting Cost Chart, and it's yours without cost or obligation.

Use this new method to learn your real blasting costs. It will help you plug profit leaks and come out money ahead in your blasting. Your nearest Atlas representative will show you how the chart works, and you can keep the actual figures within your own organization.

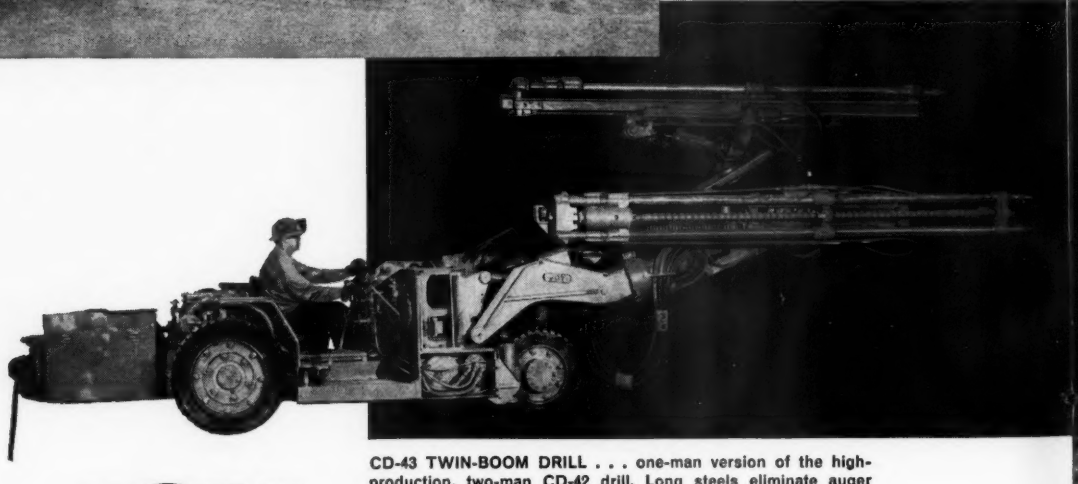
EXPLOSIVES
DIVISION
ATLAS
POWDER COMPANY
WILMINGTON 99, DELAWARE
offices in principal cities

A NEW HIGH PRODUCTION TEAM FOR HIGH SEAM COAL . . . . . .

Maximum production from high seam mines requires machines designed especially for high seams. That's why Joy engineered the "15 Series."

These machines were designed to work as a team in coal 5½ feet and higher. The twin boom CD-43 drills 10 foot holes continuously with just one operator. The powerful 15-RU reaches up to 10 feet to top cut the highest of roofs. The 15-BU loads 15 tons per minute to keep up with the cutter and drill, and the 15-SC shuttle car hauls big loads fast enough to keep pace with the rest of the team. Each unit was designed with the others in mind as part of a team. To really lower cost per ton and move the tonnages expected of a high seam operation, check into Joy's new "15 Series."

15-RU CUTTER . . . it bottom cuts, top cuts, shear cuts or anything in between. For top cutting at 8½, 9½, or 10 ft.



CD-43 TWIN-BOOM DRILL . . . one-man version of the high-production, two-man CD-42 drill. Long steels eliminate auger changes. Capacity 9 to 12 fpm, each drill.

JOY

EQUIPMENT FOR MINING

JOY MANUFACTURING COMPANY, Oliver Building, Pittsburgh 22, Pa.

In Canada: JOY MANUFACTURING CO. (Canada) Limited, Galt, Ontario

AC

All Joy coal mining equipment, including the "15 Series," is available with AC or DC.

CL7363-267

JOY

"15 SERIES"

CUT 15-RU
DRILL CD-43
LOAD 15-BU
HAUL 15-SC

15-SC SHUTTLE CAR . . . 57" high . . . haula 15 tons in one load for easier, faster loading; fewer trips; cheaper haulage.

15-BU LOADER . . . loads 15 tons per minute. Model shown is 59" high . . . lower model, 48" high, works 54" coal.

Rear-Dump "Eucs" have payload capacities of 10 to 50 tons—are powered by engines of 128 to 670 total h.p. . . . have loaded speeds up to 41 mph.

For Lower Hauling Costs in Mines and Quarries Check Euclid Performance

Open pit mine and quarries the world over have standardized on Euclid equipment for moving earth, rock, coal and ore on tough off-the-highway hauls. They know from years of experience on their own operations that "Eucs" get more work done every shift—that production cost is lower than with other types and makes of equipment.

Euclid has a complete range of sizes and models to fit every job requirement — rear dump and bottom dump haulers, self-powered scrapers and the world's most powerful crawler tractor. Your Euclid dealer will be glad to provide a production-cost estimate on your present or planned operations — be sure to see him before you replace or add to your equipment fleet — and have him show you why Euclids are your best investment.

EUCLID Division of General Motors Corporation
Cleveland 17, Ohio

Bottom-Dumps carry 13, 17 and 25 cu. yds. struck . . . special coal hauler trailers have capacities of 25, 40 and 51 tons. Full length, unobstructed door opening make these "Eucs" ideal for dumping free-flowing material into drive-over hoppers.

The TC-12 Crawler has 2 engines and independent track drive . . . 402 net h.p. . . . full power shift . . . top speed of 7.8 mph. This "Euc" tractor has unequalled work-ability for heavy dozing, ripping and similar work in mines and quarries.

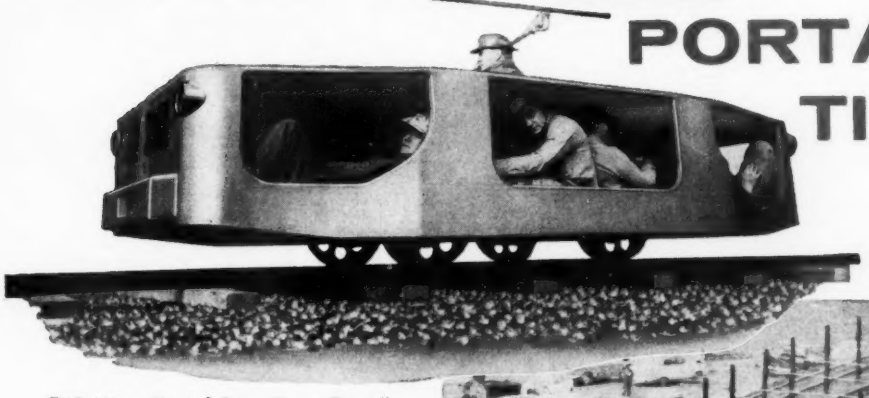
This "Twin" Scraper has 2 engines with Torqmatic Drive . . . all wheel drive permits self-loading . . . struck capacity is 24 cu. yds. There are six other Euclid Scrapers, overhung engine and six wheel types, with struck capacities ranging from 7 to 24 yds.—9 to 32 yds. heaped.

GM GENERAL MOTORS EUCLID

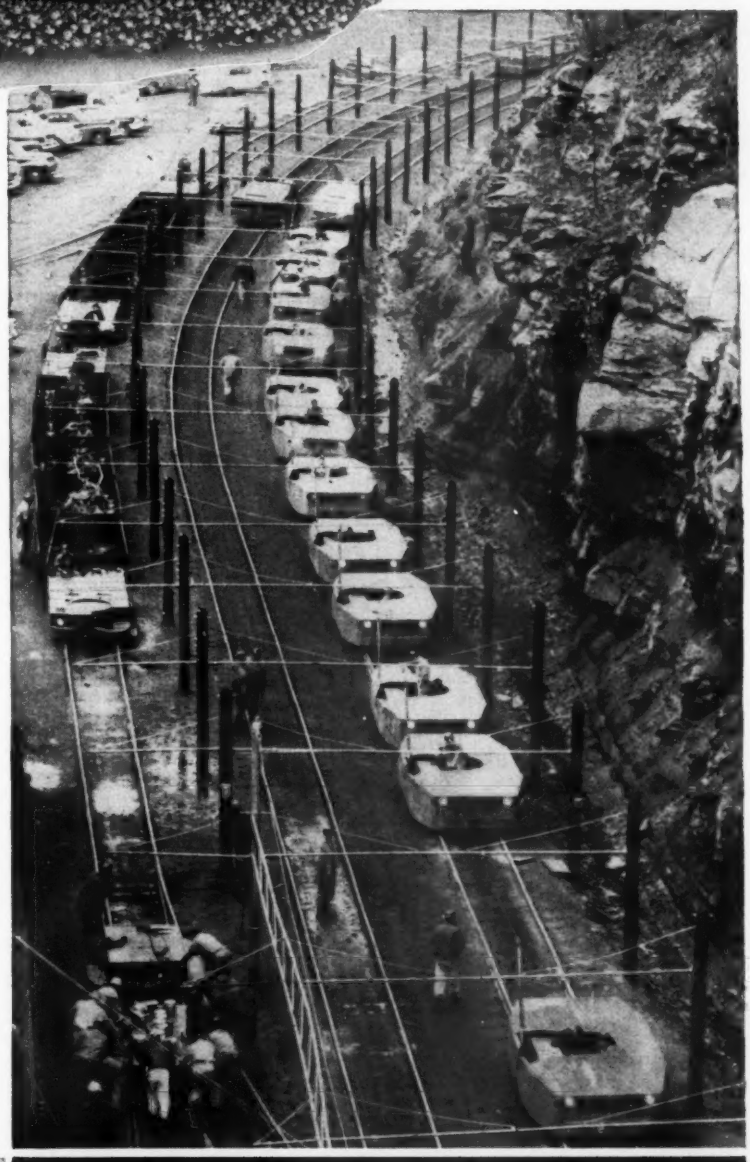
EUCLID EQUIPMENT

FOR MOVING EARTH, ROCK, COAL AND ORE

You, too, can *reduce* PORTAL TIME *up to 50%!*



TJ5 Mine Portal Bus, "Low Type"



Lee-Norse *Self-Propelled* MINE PORTAL BUS

Factual performance records prove that the Lee-Norse Mine Portal Bus can effect up to 50% savings in portal time . . . savings that result in more man hours at the section face . . . increased tonnage at a reduction in overall cost per ton.

Built in low and high types to suit your haulage road, the Mine Portal Bus features complete safety —two separate braking systems . . . split-roof design that allows operator full vision at all times.

Get your personnel to and from the working face quicker . . . safer! Check the advantages of the Lee-Norse Mine Portal Bus.

Lee-Norse Company

CHARLEROI, PA.

Tuffy® Wire Rope

"Preventative Maintenance" Will Give You Longer Wire Rope Service

Every motorist knows the importance of proper lubrication for cars. It's essential for wire rope, too. For wire rope is a "machine" of precision moving parts. And friction is enemy No. 1 of all machinery.

Lubrication during fabrication

There are two distinct phases of lubrication: in manufacture, and in use. Wire rope engineers consider the lubricant as part of the rope; the kind, consistency and amount of lubricants are controlled and applied as required. Applications are usually made hot for the inside and external surfaces.

Lubrication in the field

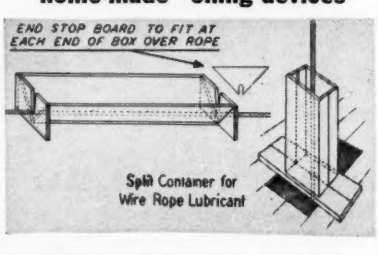
Here only an external application of lubricants is possible. It must penetrate to the inside of the rope to get a film of oil between the strands and the core. The lubricant can be applied either hot or cold, depending on its penetrating quality.

To find the best lubricant for your wire rope, talk to a local oil company engineer. He'll recommend the oil and method of application best suited to your needs.

How much and how often?

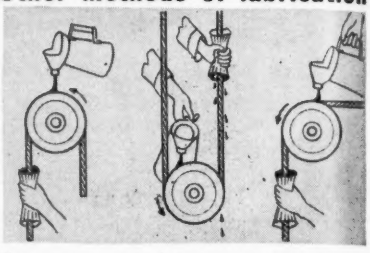
There's no set rule. It depends on service conditions. The heavier the duty, or the greater the number of bends, or the more corrosive the fluids in which the rope operates, the more frequent should be the lubrication. Remember one thing. The core is not an oil reservoir for external lubrication of the rope. No such action takes place. The oils "built" into the fiber core during its fabrication are to preserve and lubricate the vegetable fibers, not the external steel wires.

Two Types of "home-made" oiling devices



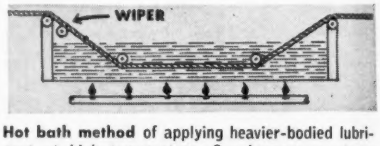
They're simple and do a good job. One is for vertical ropes, the other for horizontal. A heavy crankcase oil, cylinder oil or similar lubricant, preferably heated, is placed in the lubricators when the rope is run through.

Other Methods of lubrication



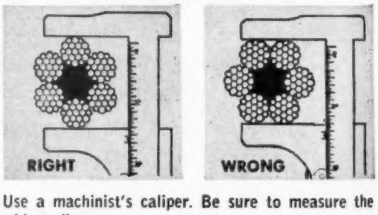
The pour-on method for manual lubrication is effective when penetrating, yet adhesive, oil is used. Oil should be hot. Hold the wiping swab BEHIND the sheave. This catches any excess oil that would be carried on along the rope.

Metal split box for bath treatment has a burlap collar or wiper at outlet end.



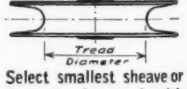
Hot bath method of applying heavier-bodied lubricant at high temperature. Gas burners or steam heat may be used. Pre-heated lubrication is always more penetrating. Rope should run through slowly to insure penetration.

How to measure rope diameter:



Use a machinist's caliper. Be sure to measure the widest diameter.

How to measure tread diameter:



Select smallest sheave or drum to be used with new rope, and measure actual diameter of tread.

Sheaves with grooves corrugated with rope lay impression should be replaced with new ones before installing new wire rope.

New ropes are usually over-size. It is advisable to have groove diameters of sheaves or drums as large as the actual calipered diameter of the new rope, or slightly larger. We recommend sizes as follows:

58-4

Tips

Recommended sizes:

Diameter of Rope	Minimum Dia.	Maximum Dia.
1/4-5/16	+ 1/64"	+ 1/32"
3/8 - 3/4	+ 1/32"	+ 1/16"
7/8 - 1 1/8	+ 3/64"	+ 3/32"
1 1/4 - 1 1/2	+ 1/16"	+ 1/8"
1 5/8 - 2 1/4	+ 3/32"	+ 3/16"
2 3/8 and larger	+ 1/8"	+ 1/4"

How to check groove diameter:

Ordering is ABC-Simple!

No complicated codes or long list of specifications. Just say "Tuffy," give type (Scraper Rope, Dozer Rope, etc.), length wanted and size. Just that easy!

Good Man to Know — Your Nearby Union Wire Rope Distributor

Whether your wire rope need is a scheduled replacement or a red-hot emergency, your Union Wire Rope distributor is ready with "right-now" service. He keeps varied stocks of Union standard constructions and the Tuffy Special Purpose Ropes. And he's backed by quick service from his nearby Union Wire Rope depot.

If it isn't rope you need, but advice on a wire rope problem, he's just as ready to help. If you don't know your Union Wire Rope distributor already, look under "Wire Ropes" or "Slings" in your telephone directory yellow pages.

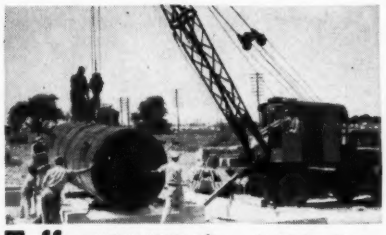
Too much strength can be a weakness... Wire rope must be BALANCED

Sometimes extra strength is heavily stressed in selling wire rope. While strength is important in every operation where wire rope is used, it is not the only important quality, and there are cases where excessive strength is a liability.

For example, the manufacturers of scrapers have designed the components of their equipment to take certain loads. These loads are controlled by or subject to the ultimate strength of the rope. Larger ropes with their accompanying higher strength do not break but *the equipment itself begins to* break up. Another feature of scraper rope is resistance to crushing. Strength is not the factor which controls the best design to resist crushing.

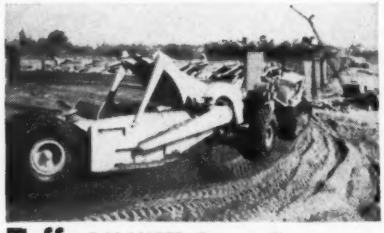
Union Wire Rope gives you the PROPER BALANCE of strength, toughness, flexibility and other properties most desirable for rope efficiency and long life. Don't settle for less. Your Union Wire Rope distributor has the BALANCED rope for every use.

Special Purpose Ropes: tailored & BALANCED for special uses



Tuffy BALANCED Slings & Hoist Lines

Top-performing team in every type of materials handling. Tuffy Slings are made of a patented, machine-braided fabric; stays extra flexible, can't be seriously hurt by knotting or kinking. Tuffy Hoist Line is a special construction of super flexibility and toughness.



Tuffy BALANCED Scraper Rope

It's flexible enough to withstand sharp bends, yet stiff enough to resist looping and kinking when slack. Moves more yardage per foot because it's specially built and balanced to take the beating of drum-crushing abuse.

Tuffy BALANCED Dozer Rope

Built to give you longer service with less downtime. 150' reels of 1/2" or 9/16" mounted on your dozers allow you to cut off worn sections without wasting good rope. Put Tuffy Dozer Rope on the job and watch costs go down!

Tuffy BALANCED Dragline Rope

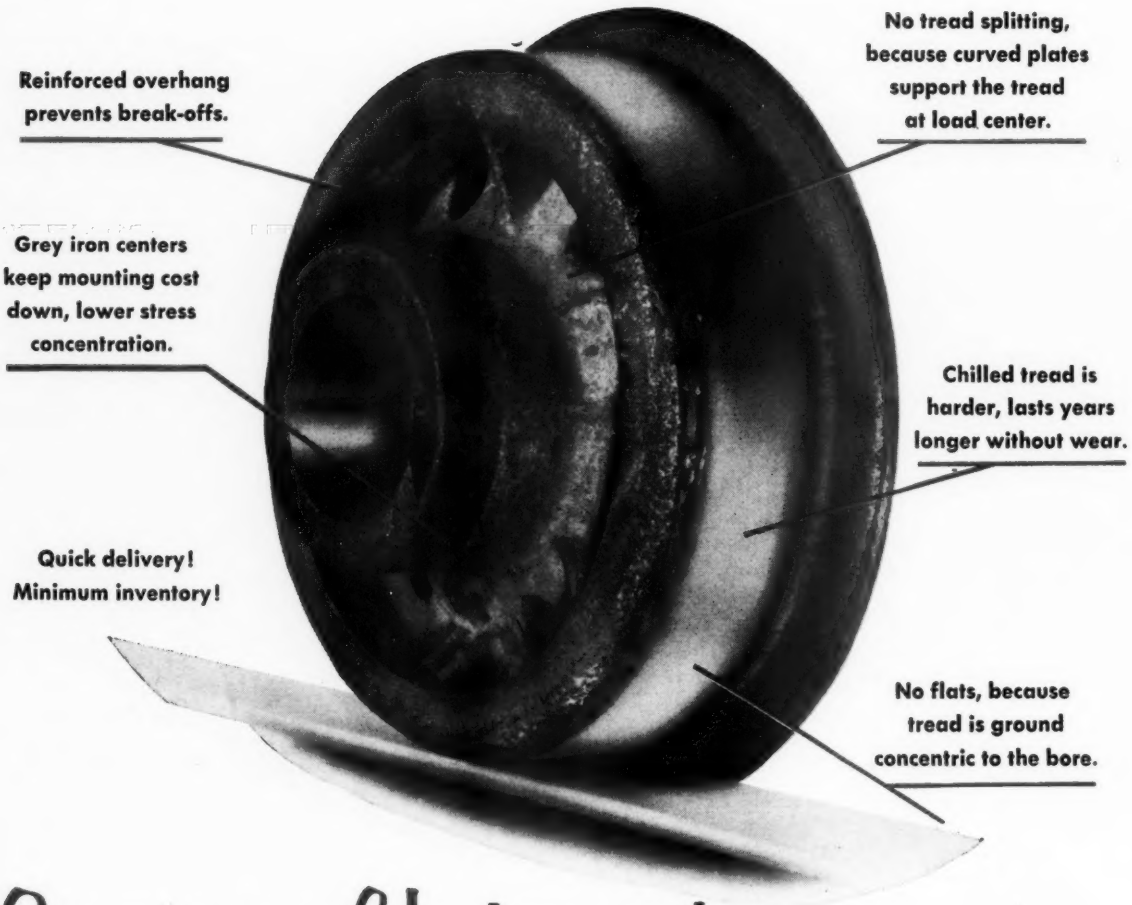
Made to give you maximum abrasive resistance with super flexibility. Rides smoothly on grooves; hugs the drum when casting for full load. Consistently dependable in handling any material — wet or dry dirt, sand, gravel, rock, cement or minerals.

union Wire Rope corp.

SUBSIDIARY ARMCO STEEL CORPORATION

2144 Manchester Ave. **Kansas City 26, Mo.**

Specialists in high carbon wire, wire rope, braided wire fabric, stress relieved wire and strand.


Reinforced overhang prevents break-offs.
No tread splitting, because curved plates support the tread at load center.
Grey iron centers keep mounting cost down, lower stress concentration.
Chilled tread is harder, lasts years longer without wear.
Quick delivery! Minimum inventory!
No flats, because tread is ground concentric to the bore.

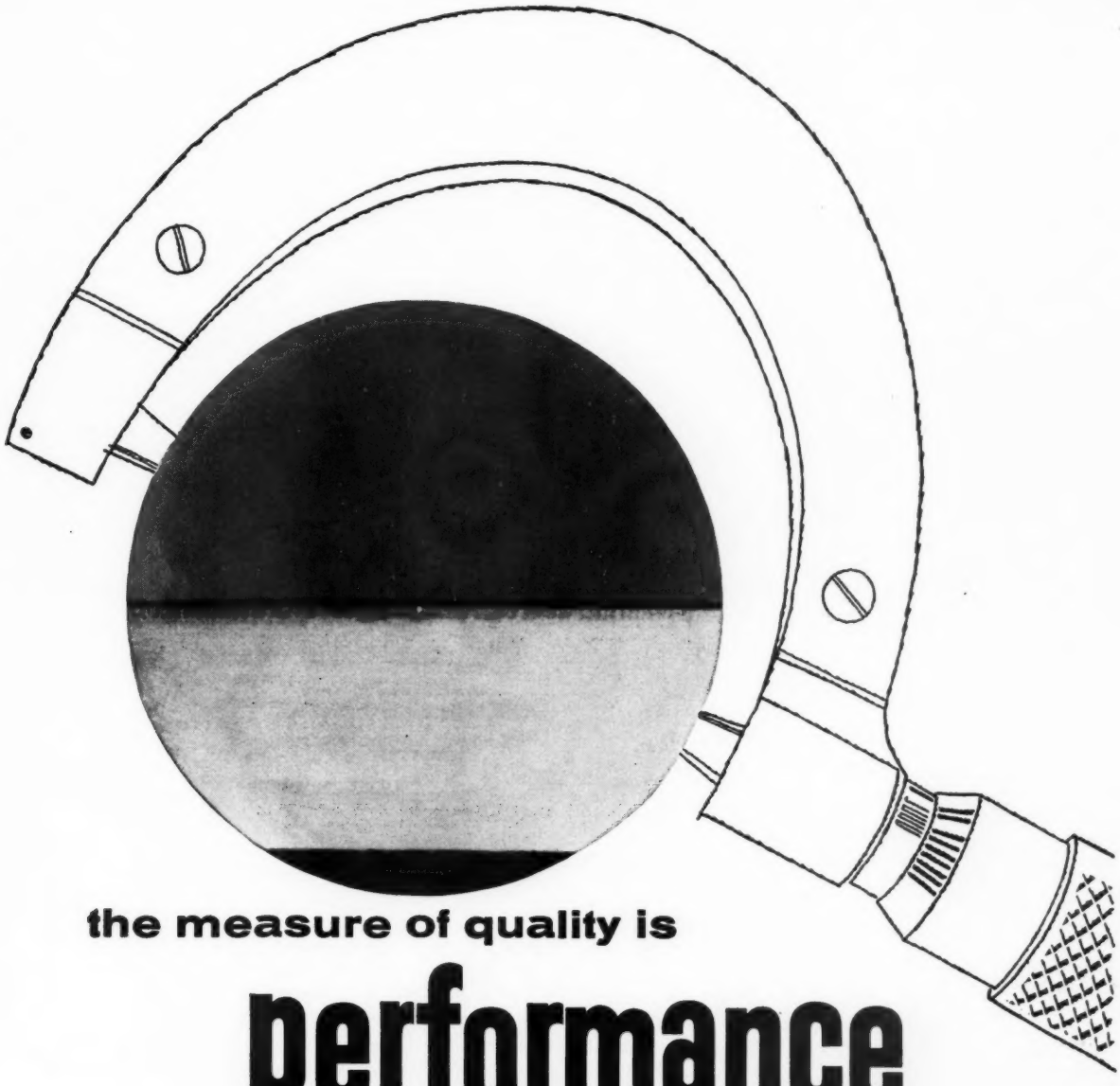
Center of Interest

for cost-conscious operators!

In mine after mine, acf *Load-Support* Chilled Tread Mine Car Wheels give millions of ton-miles of low-maintenance service! Extra quality in every feature gives longer service in every use, minimizes haulage delays for wheel repairs, lowers mine car wheel inventory requirements. Ask your American Car and Foundry representative for facts and figures! AMERICAN CAR AND FOUNDRY, Division of acf Industries, Incorporated, 750 Third Ave., New York 17, N.Y. *Sales Offices:* New York—Chicago—St. Louis—Cleveland—Washington, D. C.—Philadelphia—San Francisco—Berwick, Pa.—Huntington, W. Va. *Plants:* Berwick, Pa.—Huntington, W. Va.—St. Louis, Mo.

acf
AMERICAN CAR AND FOUNDRY
DIVISION OF ACF INDUSTRIES, INCORPORATED

LOAD SUPPORT MINE CAR WHEELS



the measure of quality is

performance

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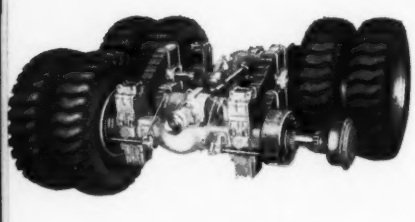

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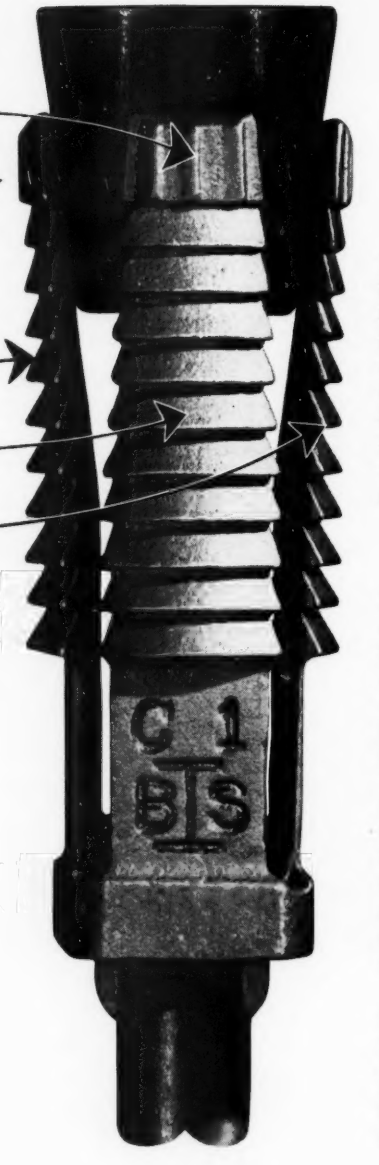

This is the expansion shell used on the end of a Bethlehem Headed Roof Bolt. Inserted in a hole drilled into the mine roof, the serrated leaves of the shell expand quickly when the tightening of the bolt draws the plug down on the threads. In a matter of seconds, the shell and bolt are locked in the hole, thus providing a firm, secure roof.

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Hard sulphur balls in this Indiana No. 5 Seam were holding bit cost at 6.4 cents a ton until Kennametal bits were installed. By using rugged Kennametal U7 bits, this cost was reduced to 3.25 cents a ton.

About 14 places, 26 feet wide, are cut during a normal shift, using the unique three-pass cutting method described at the right. By this procedure, found to be most efficient for the unusual conditions encountered here, a record 23 places were once cut in a single shift, using the Kennametal U7 bits.

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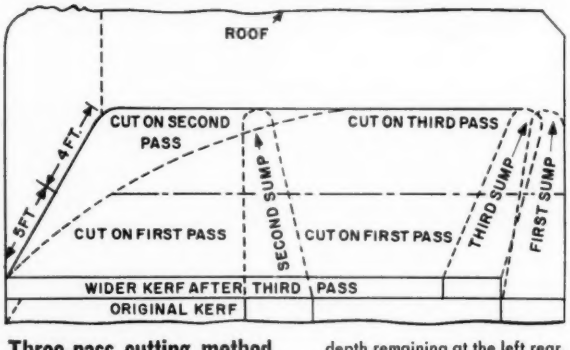

Three-pass cutting method

1. After sumping in a full nine feet along the right rib, the cutterbar is withdrawn four feet.
2. *First pass* is made across the full width of the face.
3. Cutterbar is sumped in a full nine feet at the *center* of the face.
4. *Second pass* cuts the four feet depth remaining at the left rear.
5. Cutterbar is again sumped in nine feet at the right rib.
6. Heel of the bar is raised ten inches.
7. *Third pass* cuts the four feet depth remaining at the right rear, continuing across left rear, widening the kerf and clearing cuttings.

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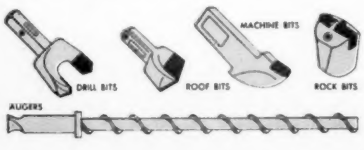


EDITORIALS

ROBERT W. VAN EVERA, Editor

DECEMBER, 1958

THE PRACTICAL AND THE ESTHETIC

THE Senate Interior Committee has held a number of hearings, both in Washington and in the West, to sound out public sentiment on a bill (S. 4028) introduced in the 85th Congress which would create a vast "National Wilderness Preservation System" in which commercial activities would be barred except by direct Presidential permission. No action was taken on this proposal, but its proponents plan to seek its passage during the next Congress.

This measure, according to its advocates, is needed to preserve "the frontier wilderness as an outlet from the grinding pressures of a highly urbanized society." It defines a wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." It says such areas are needed to serve "the recreational, scenic, scientific, educational, conservation and historical needs of the people." It not only bans commercial enterprise of any character in wilderness areas, but prohibits road construction, use of motor vehicles, motor boats, aircraft, and the erection of buildings or structures.

While there may be wilderness areas that should be preserved in their untrammeled state, sufficient authority already resides with the Executive for that purpose. And what of the public interest? Is it wise to carve out vast new primitive areas from the Federal land holdings, thinking only of their esthetic value and prohibiting multiple-use developments for the public good? Miners, cattlemen, Chambers of Commerce, lumbermen, forestry groups, oil men, farm groups and major women's organizations answer "No!"

The American Mining Congress voiced its strong opposition to S. 4028 before the Senate Interior Committee last July. It declared that the proposal is contrary to the principles long espoused by the mining industry—that national policy should provide incentives to prospectors to search out new mineral resources, thus contributing to the development of vital industries in the Western States.

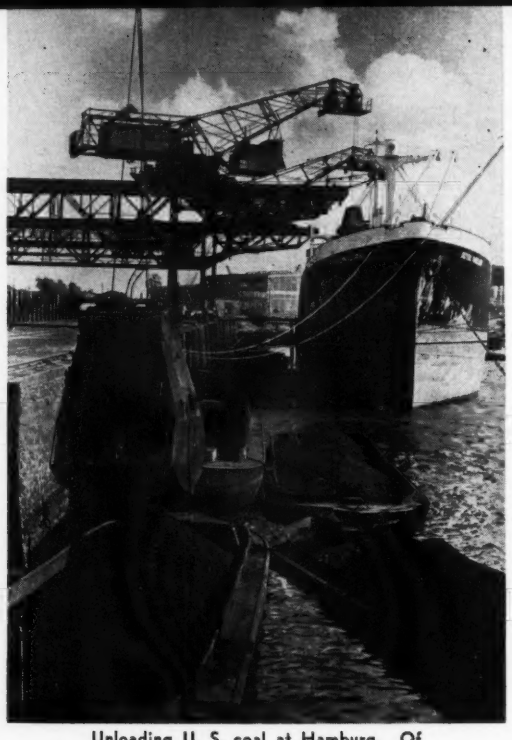
Congress, nearly a century ago, recognized that mining on the public domain should be encouraged in order to develop our resources for the nation's benefit. In recent years, Congress has followed the policy of providing for multiple use of Federal lands, specifically pointing out that "it is no longer in the national interest that the public domain should be used for one of the uses to the exclusion of the other."

The creation of a national wilderness preservation system is contradictory to this Congressional policy. This view is wholeheartedly endorsed by representatives of the aforementioned industries and civic groups. Their statements at the Interior Committee hearings forcefully stress that the interests of national security, growing population, and an expanding economy would not be served best by providing for a single use of Federal lands.

The 85th Congress has already enacted a law providing for a Study Commission to make recommendations as to coordinating recreational use of public lands with economic uses. At the very least, Congress should not act on any legislation in this field until the study group has made its report.

Approval of any measure similar to S. 4028, which would limit the use of large areas of Federal lands to esthetic purposes without regard to its multiple-use potential or its economic development, is not justified. Such legislation would, in fact, withhold even the esthetic values from many sportsmen and sightseers who, under normal conditions, might have the fortitude and temerity to penetrate these wilderness areas.

The proposal is unwarranted, unwise, and inconsistent with the tenets of good Government. It should be rejected.



Unloading U. S. coal at Hamburg. Of Germany's total 1957 U. S. coal imports, a third or 5,000,000 tons were shipped via Hamburg

Europe and the

When West Germany embargoed the issuance of new licenses for American coal imports, the editors of Mining Congress Journal contacted a German correspondent for an on-the-spot analysis of the situation. U. S. coal producers will be particularly interested in the writer's prediction of continued heavy American coal sales to Europe, particularly to West Germany, and the reasons for this optimistic outlook

By OMER ANDERSON

IN West Germany pithead stocks of unsold coal passed the 10,000,000-ton* mark. Consumer coal stocks rose to 12,000,000 tons—twofold the normal consumer stockpile.

In the six countries of the European Coal and Steel Community—West Germany, France, Italy, Belgium, Holland and Luxembourg—coal stocks at the mines climbed to 23,500,000 tons of coal (not including brown coal) and 5,800,000 tons of coke. ECSC consumer stockpiles mounted to 21,400,000 tons.

This was the surface situation in the autumn of 1958 when West Germany embargoed the issuance of new licenses for American coal imports.

American coal sales to West Germany—and to the ECSC—have been rising year by year: in 1955, 7,000,000 tons; 1956, 11,500,000 tons; 1957, 15,974,000 tons. Germany has been the bellweather for American coal sales to the ECSC. German sales have amounted to roughly half of all American coal sales to the ECSC, and ECSC purchases of American coal have risen each year proportionately to German coal imports from the United States.

Last year, coal accounted for 23 percent of all West German imports from the United States. The Germans paid $300,000,000, including freight charges, for U. S. coal purchases—this despite the fact Germany has a chronic dollar gap in its trade with the United States and Canada.

For the year 1958, American coal sales to Germany will be down substantially from 1957—down to around 12,000,000 tons.

The 1958 decline together with Germany's U. S. coal embargo point *superficially* to the likely collapse of the big European market for American coal.

Genesis of Germany's Coal Glut

But coal is Germany's most complicated industry; in fact, Europe's problem industry. Europe's current coal glut is compounded of multiple and diverse forces and factors. In-depth analysis of Europe's energy situation suggests that the coal glut is largely an artificial, temporary condition. Long range, the outlook is for steadily rising European imports of American coal, at least until 1970, when nuclear energy will be available in unlimited volume.

The coal glut traces back to the Ruhr industry's price boost of October 1, 1957. Chancellor Konrad Adenauer's Christian Democrats had won a landslide victory in the national elections on an anti-inflation platform. But the day after Adenauer's electoral triumph, the coal industry kicked over the traces, scheduling price increases for October 1, 1957, and for April 1, 1958. The October price increases were the equivalent of $1.10 a ton on anthracite, $1.48 on coke, and 71 cents on brown coal. The April 1, 1958, boost was to have averaged an additional 50 cents a ton.

The coal industry's announcement of price boosts, coming as it did on the heel's of Adenauer's vote victory, raised the hackles of Economics Minister Ludwig Erhard. Originally, the industry had planned to combine the October 1957 and April 1958 boosts as a single price jump to take effect October 1, 1957. But the two-step increase was substituted to mollify Erhard.

German coal claimed it needed the price boosts to accumulate more investment funds for mine modernization and to cover the industry's increased contributions to miner social security under the 1957 amended social security laws.

Erhard then embarked on what has developed as a zigzag course with respect to American coal. Casting about for counter-pressure on Ruhr coal, the economics minister considered putting government-owned coal

*Tonnage figures are in metric system (1 metric ton = 2204.6 lb).

U. S. Coal Importation Issue

mines into price competition with the Ruhr. But this would cost the government money, and the number of mines were too few (20 percent of total output) to exert decisive influence on the Ruhr price structure.

Instead, Erhard pounced happily onto American coal. It was, from the economic minister's viewpoint, the perfect pressure instrument. Erhard announced that American coal would be made competitive with German coal.

His main move in this direction was a cut in freight rates on the government-owned German Federal Railways for American coal. The freight rate cut took effect last March 17, the new rates for U. S. coal being only four percent higher than for domestic coal. Rates were cut from North Sea ports—and also for U. S. coal shipments from harbors on the Upper Rhine, Main and Neckar.

Erhard's freight-rate cut dovetailed with the sharp drop in Atlantic ocean freight rates. The rate for hauling 10,000 tons of coal from a U. S. port on the North Atlantic to Europe plummeted to $4.20 a ton.

Moreover, the freight-rate cuts coincided roughly with a drop in petroleum prices, stimulating heating oil consumption throughout the Continent. Also, the 1957-1958 winter was unusually mild on the Continent.

Finally, the backwash of the U. S. recession reached Europe. Ruhr steel mills, which had been operating at nearly full capacity, cut back to around 82 percent of capacity. German steel production, which last year soared to nearly 25,000,000 tons, has leveled off in 1958 to around 22,500,000 tons.

Such was the genesis of the coal glut. By early spring, coal producers were demanding government action to assist the industry.

Ruhr mines began furloughing miners. On the average, West Germany's 400,000 miners have lost several days work each month since the pileup of unsold coal.

But with U. S. coal underselling Ruhr coal in north Germany, and roughly competitive with Ruhr coal even in Bavaria, the German market for U. S. coal boomed. Under existing contracts, about 40,000,000 tons of U. S. coal will be shipped to West Germany in the next three years—despite the Bonn government's embargo, which applies only to new contracts.

Imported U. S. Coal to Be Resold Outside Germany

In return for curbing U. S. coal imports, Erhard extracted a number of "concessions" from the domestic coal industry, including:

1. **A ten percent rebate to industrial users' purchases above previous normal purchases.**
2. **A similar rebate on purchases of one million tons and over of foundry coke.**
3. **A stepped-up German coal export campaign.**
4. **A promise that the problem of the marginal Ruhr mines will be "solved."**

As coal stocks mounted, the Ruhr quietly cancelled the scheduled April 1 price boost. But, aside from the rebate, no domestic coal price cut is in the offing.

The price rebate offer applies also to purchases within the ECSC. Chief beneficiaries within the ECSC circle will be French steel plants in Lorraine, which rely on Ruhr coal, and Luxembourg steel. German coal exports between 1951 and 1957 have averaged 14,000,000 tons of coal a year, virtually all to ECSC countries.

Erhard and the Ruhr coal men have devised an ingenious plan for meshing imports of U. S. coal flowing in under long-term contracts with a German coal export sales campaign. The plan is to resell as much of the imported American coal as possible outside Germany, principally to ECSC members. Germans would pay the U. S. suppliers in dollars, but resell the coal for soft currencies, and, very likely, at cut-rate prices. It will mean substantial losses for the Ruhr coal industry, but the Ruhr has agreed to give the scheme a try.

Kloeckner-Huette, one of Germany's biggest steel producers, recently opened a waterside plant at Bremen—a plant which subsists entirely from waterborne cargoes. The port installation pictured above is directly adjacent to the steel plant and was constructed as part of the plant. Ruhr coal is permanently out of the picture for this operation

German industry favors U. S. coal generally because: (1) long-term contracts guarantee price stability, and (2) availability of supply

U. S. Coal Embargo—Is It Justified?

Prospects for continued heavy American coal sales to Europe, and particularly to Germany, are rooted in these facts:

1. **The U.S. coal embargo can be no more than temporary, a breathing spell for the Ruhr to sort out its problems.**
2. **A variety of German economic interests, ranging from the maritime to the steel industries, have a considerable stake in continued American coal exports.**
3. **Germany's coal industry faces increasing competition from petroleum as well as from American coal. German coal, long range, must reorganize output and sales on a competitive basis. This inevitably will mean the closing down of marginal mines, which influence the domestic price.**
4. **Basically, and most important, Europe will continue to be confronted with an energy gap for at least the next decade, according to the consensus of various authoritative surveys.**

The Germans invoked the U. S. coal embargo under Article 19 of the General Agreement on Trade and Tariffs (GATT), which sanctions emergency measures to protect an ailing domestic industry. Officials at the U. S. Embassy in Bonn, however, openly question whether the Germans can back up their claim of a coal "emergency."

U. S. Embassy sources say that the U. S. coal embargo, if prolonged, should be answered with a countermeasure: an embargo on German automobile exports to the U. S. One Embassy official commented:

"The Germans complain about their jobless miners, but the figures show that each miner lost less than two days work a month. Our automobile workers in Detroit wouldn't think, in view of their experience last year, that this is so bad.

"The Germans justify their embargo by claiming that an emergency confronts the mining industry. But last spring, 20 percent of American automobile production was stockpiled, affecting the U. S. steel industry and a whole series of other industries—and badly.

"We had more justification, in connection with the automobile sales slump, to take action under Article 19 of GATT than have the Germans."

U. S. Embassy officials say the U. S. coal embargo impact will not be felt immediately. Existing contracts assure substantial U. S. coal shipments until September 3, 1961, when most of the current contracts expire.

German Industries and American Coal

Meantime, Ruhr coal is finding Germany a house divided on the question of U. S. coal. Large-scale American coal shipments have been in progress to Germany since 1952. In the intervening six years, U. S. coal has become a subtle, if still negligible, force in German economic life.

Germany's maritime industry has come to count on coal to take up the slack in the general shipping slump. For example, some 70 ships are moored permanently at Hamburg for want of cargoes. Yet German shipyards are backlogged with orders for the rebuilding German merchant marine, which in September first matched the tonnage of the country's prewar merchant marine. American coal cargoes are tremendously important to German ship operators.

U. S. coal is also important to Germany's North Sea ports and its inland ports and barge traffic. As the City of Hamburg put the situation in a recent press release: "Germany can't do without U. S. 'black gold'." Of Germany's total 1957 U. S. coal imports, a third—5,000,000 tons—were shipped via Hamburg.

Germany's steel industry has been weaned to U. S. coal. Quality and availability are reasons. But a more durable factor is the steel industry's march to the water.

Kloeckner-Huette, one of Germany's biggest producers, has just opened a waterside plant at Bremen (with annual capacity of 500,000 tons)—a plant which subsists entirely from waterborne cargoes. Its coal comes from the United States and Norway and its ores from Sweden, Canada and Venezuela. For Kloeckner's Bremen plant, Ruhr coal is permanently out of the picture.

All over Europe steel is moving to the waterside, and the industry's concensus is that this trend can't be reversed.

Similar German economic readjustments have occurred—readjustments pegged to permanent U. S. coal importing. The German electricity generation industry, for example, has come to rely increasingly on U. S. coal.

German industry favors U. S. coal generally because (1) long-term contracts guarantee price stability, and (2) availability of supply. The Ruhr will sell only on short-term contracts, mainly for six months with one year as the maximum.

The current glut is a phenomenon; until last winter Germany has been gripped by a severe coal shortage. Sales by allocation have been the rule. German industry in general is wary of a return to coal shortages, particularly with the end of the U. S. recession.

German coal consumers generally—most of all German housewives—regard U. S. coal imports as a safeguard against capricious pricing by the domestic coal industry. As with general industry, the housewife, in winters past, has found coal in short supply and expensive.

Ruhr Coal's Stake in American Coal Imports

Strangely, the Ruhr coal industry itself has a stake in continued U. S. coal imports—in fact wants to keep U. S. coal coming. This odd circumstance stems from the coal industry's sales organization—the centralized marketing arm of the industry. When

coal was in short supply, the Ruhr coal sales organization contracted for U. S. coal importation.

It was—and still is—good business for the sales organization. Therefore, the sales organization, while understandably not trumpeting the fact, has suggested that importation of U. S. coal be continued by those importers able to show they had a non-German buyer for the U. S. coal. This strategy was aimed at the independent German importer, who normally imports his U. S. coal first and then shops for buyers.

The Bonn government's efforts to promote "peaceful coexistence," as it is termed in political circles, between German coal and the booming oil industry is probably the most significant sidelight to the U. S. coal importation issue.

Not even in England has coal traditionally influenced general economic life more than in Germany. The country's finely-balanced industrial economy has rested on feet of coal. The Ruhr concentration of German industry is the product, pure and simple, of Ruhr coal deposits.

Now the Ruhr's detractors are quipping that the German industrial giant's feet of coal have turned to clay.

In 1957 Ruhr output (not including brown coal) was 133,200,000 tons, or 53 percent of ECSC production (see chart on European coal production). Germany's coal industry employs 540,000 persons—7.5 percent of the entire West German labor force. Ruhr coal sales turnover accounts for about four percent of the entire West German industrial turnover. Despite the inroads of petroleum, coal still supplies 86 percent of West Germany's energy requirements, compared with 65 percent for the entire ECSC area.

But, as the accompanying chart of production figures indicates, German coal is an ailing industry. This fact is illustrated even more graphically by statistics on miner productivity, which has declined alarmingly over the last two decades, along with a general European miner productivity sag. Factors are antiquated mine equipment and exhausted seams. Ruhr seams, in particular, are narrow, twisting and extremely difficult to work with mechanized mining. But the decline in miner productivity is a European phenomenon, as the accompanying chart on yearly production per miner clearly shows.

EUROPEAN COAL PRODUCTION FOR THE 1937-1957 DOUBLE DECADE
(NOT INCLUDING BROWN COAL PRODUCTION)
(In millions of tons)

Country	1937	1955	1956	1957	% Change 56-57
Belgium	29.9	30.0	29.6	29.2	minus 1.0
Czechoslovakia	16.8	22.1	23.4	24.2	plus 3.4
France	44.3	55.3	55.1	56.8	plus 3.1
Saar	13.4	17.3	17.1	16.4	minus 4.1
West Germany	137.6	130.7	134.4	133.2	minus 0.9
Holland	14.3	11.9	12.0	11.7	minus 2.5
Poland	66.0	94.5	95.6	94.0	minus 1.7
England	244.3	225.2	225.6	227.0	plus 0.6
Rest of Europe except Russia	12.9	27.9	28.6	29.9	plus 4.5
Europe (excluding Russia)	579.5	614.9	621.4	622.4	plus 0.2
Russia *	128.0	391.0	429.2	463.0	plus 7.9

* Including brown coal production

YEARLY PRODUCTION PER MINER
(In tons)

Country	1936	1938	1950	1952	1955	1956
West Germany	582	540	367	383	398	403
Saar	.....	439	380	424	466	463
France	355	293	292	334	383	393
Belgium	306	283	244	255	294	289
Holland	685	653	460	419	389	386
England	389	372	408	415	404	405

Petroleum's Inroads on German Energy Market

Europe's coal decline has been offset by the petroleum upsurge. For example, in the first half of 1958—while Ruhr coal stocks were building up—West Germany boosted oil consumption an even third over the first half of 1957.

Petroleum's inroads on the German energy market are dramatized by the North Sea-Ruhr pipeline, connecting the port of Wilhelmshaven with Cologne. This 275-mile pipeline, Europe's biggest, has just been completed and is scheduled to go into operation early in 1959. The pipeline, along with a pipeline being constructed between Cologne and Rotterdam, will serve the new refining center being developed at Cologne by the German oil industry.

For the German public, coal versus oil competition was dramatized by no less a personage than Chancellor Konrad Adenauer. The chancellor switched from coal to oil heating of his home at Rhoendorf, the Bonn suburb. There was an outcry from the coal industry, but the Chancellor stuck to the switch. His home is on a Rhine hillside, and Adenauer said the removal of ashes and replenishment of coal stocks was too much work for his household staff.

Curiously, Germany's petroleum industry is fighting the U. S. coal embargo—and for a logical reason. Ruhr coal is pressing for curbs on heating oil imports—the import of crude for heating oil production.

The oil industry, at least until the current coal glut, had sold the Bonn government on a long-range energy gap. The most authoritative statement of this thesis is that of Dr. Heinrich Koehn, head of the economics research department of Esso AG, Hamburg. His projection encompassed all forms of energy—coal, oil and hydro-electricity (but not nuclear energy)—and established a fixed relation between the increase in industrial production and the demand for energy.

He came to the conclusion that the domestic coal industry, even when operating at maximum production, would not be able to satisfy the energy demand. The energy gap, he maintained, would have to be closed by increased imports of fuel oil and coal.

The coal and oil industries and the Federal Economics Ministry concurred with Dr. Koehn's findings.

In the over-all national energy plan extending to the year 1965-1966, submitted to the Bonn Parliament by the Economics Ministry in 1957, expansion of the oil industry is envisaged as follows:

Crude oil throughout to rise from 10,300,000 to 30,000,000 tons by 1966, and refining capacity to be increased correspondingly.

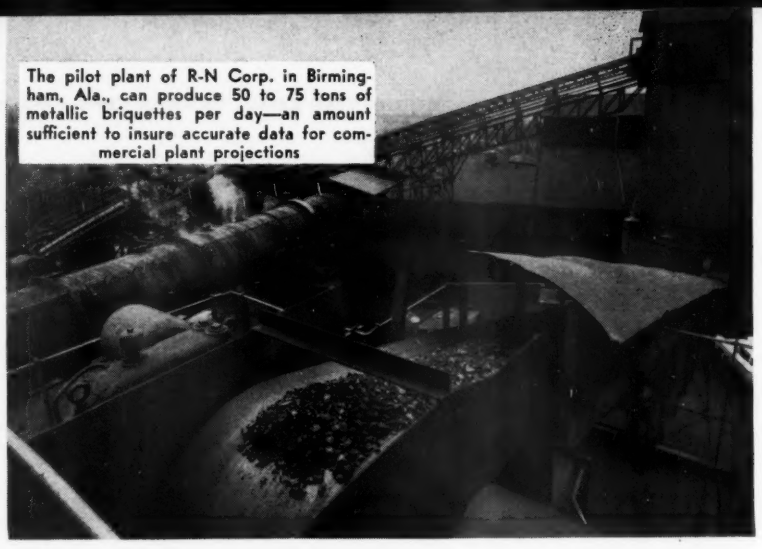
Crude oil imports to be quadrupled (to 24,500,000 tons), with 5,500,000 tons to come from domestic production.

Fuel oil production to be increased tenfold—to 16,000,000 tons, mainly by boosting the proportion of fuel oil extracted from every ton of crude oil from 20 percent to 50 percent.

The oil industry's ambitious expansion program has generated alarm within the coal industry. Ruhr coal fears competition from oil more than from American coal. German consumers of American coal are not lost permanently to Ruhr coal. As long as furnaces are equipped for coal burning, the Ruhr mines and sales

(Continued on page 41)

DIRECT REDUCTION of Iron Ores in a Rotary Kiln



The pilot plant of R-N Corp. in Birmingham, Ala., can produce 50 to 75 tons of metallic briquettes per day—an amount sufficient to insure accurate data for commercial plant projections

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The R-N Process is extremely flexible and can treat low and high grade, magnetic or non-magnetic, iron ores with equal efficiency. Ores treated to date in the Birmingham, Ala., pilot plant have varied in iron content from 30 to 65 percent. Solid carbon fuels containing up to 7.5 percent sulfur have been successfully utilized to produce metallic iron briquettes containing greater than 90 percent iron, less than three percent silica and less than 0.05 percent sulfur. For most ores, phosphorus rejection has been 90 percent or better.

THE R-N process, involving the direct reduction of iron ores in a rotary kiln is a joint development of the Republic Steel Corp. and National Lead Co. Work on this process has extended over the past 14 yrs. The original work was initiated by National Lead to increase the titanium values in ilmenite ores. Initial pilot plant work on ilmenite ore was done in Norway and later extended to iron ores.

In 1953, Republic Steel and National Lead joined forces to pursue this study, and constructed a semi-commercial pilot plant at Birmingham which commenced operation in December 1954. This plant is of such a scale as to permit the production of a carload of metallic briquettes (50 to 75 tons) per day. This production rate not only permits obtaining accurate process and engineering data for commercial plant projections but also provides sufficient tonnages of product for steel melting furnace tests.

Direct reduction processes have been under investigation for many years. The R-N Process has been economically proven on a wide range of ores, both low and high grade, using a variety of low grade fuels. Detailed engineering for full scale commercial plants is now in preparation.

Savings and Better Use of Raw Materials Spur R-N Development

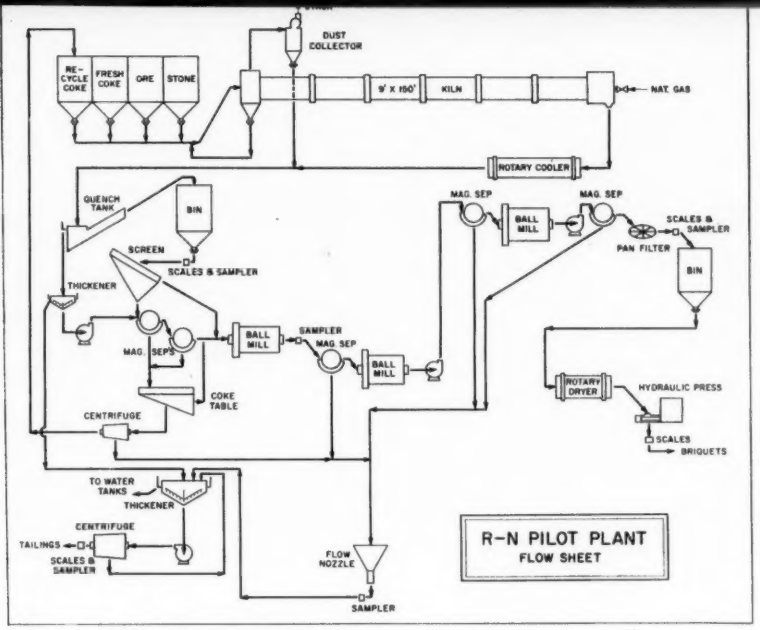
There are a number of basic elements which have motivated the development of all processes to produce metallic iron, directly from crude magnetic or non-magnetic iron ores.

1. **Production costs for direct reduction processes which can utilize low grade ores and coals will be lower than present methods.**
2. **Capital investment in blast furnaces will continue to be increasingly hazardous unless additional supplies of high grade feed can be developed on a competitive basis with present ore feed stocks. Direct reduction processes for production of metallics and the installation of electric melting furnaces or open hearths, for new installations and for those requiring increased steel capacity, offer the lowest capital investment.**
3. **Metallurgical coking coals have become less available and more expensive. Direct reduction processes permit the use of low cost chars as the reductant.**
4. **The ratio of non-magnetic to magnetic low grade iron ores is in the order of 10 to 1 in the United States.**

For these reasons it was decided to determine the applicability of the process, as developed in Norway for ilmenite ores, to American iron ores. In 1949, 2000 tons of American iron ore and 500 tons of coke breeze were sent for pilot plant tests to Norway where National Lead has its pilot plant for studying titaniferrus iron ores. Half of this ore was hematite washed ore from the Tobin mine and the remainder was non-magnetic taconite from the Marquette range. American coke breeze was the solid reductant. This test established the technical feasibility of the process for American ores.

It was felt that further development of the process should be carried on in the United States, using ores found in this country. Furthermore, it was decided that the process could best be developed by the joint action of National Lead and Republic Steel. A program was established which involved setting up a development laboratory in Brooklyn, N. Y., and a pilot plant in Birmingham, Ala.

In the past, direct reduction processes have not succeeded for a variety of reasons. Hence, it is interesting to consider how the R-N Process overcomes the earlier difficulties encountered in such processes. The fac-



tors playing an important part in the R-N direct reduction of iron ores are:—

1. **Careful control of combustion will give the required temperature and atmosphere over the ore bed, and maintain the carbon monoxide (CO) content of the off-gas at a minimum. The R-N kiln temperature is easily maintained below the melting point of the major constituents or products.**
2. **Beneficiation techniques involving both magnetic and/or gravity separation after reduction facilitates gangue removal and overall iron recovery in the economic treatment of ores for the production of metallic iron.**
3. **Suitable cooling after reduction provides the proper physical properties in the metallic iron, and minimizes reoxidation.**
4. **Proper temperature gradient and balanced ratio of carbon monoxide (CO) to carbon dioxide (CO_2) provides a reduction of the iron oxide in ore to 95 percent iron or better.**
5. **Agglomeration produces a finished product of such shape and density as to provide the best feed for the electric and open hearth furnace.**

Having these process conditions it is possible to treat a very wide variety of ores and obtain metallic iron products low in sulphur and phosphorus. The theoretical aspects of reduction of iron oxides by carbon monoxide (CO) are sufficiently well known to avoid need for repetition here; the theoretical aspects of the sulphur and phosphorus elimination will be discussed later in the paper. With this background, the discussion of the R-N process will center around the process flowsheet and the equipment required.

Rotary Kiln Key to Process

Experience with laboratory tests has shown that practically any iron ore can be successfully treated by the R-N Process, once the characteristics of the ores and process details are determined. For any given deposit of ore and location of plant, it is considered desirable to first treat a reasonable amount of ore in the pilot plant in order to define the technical and economic factors and to furnish accurate data for design of a full scale plant.

The R-N Process as described here in detail is based on the operation of the pilot plant in Birmingham. The R-N Process has been extensively developed and is ready for commercial installation. To date, approximately 120,000 tons of ore have been successfully treated on a semi-commercial scale.

Along with the ore, an excess of solid carbonaceous fuel is fed into the kiln. The excess carbon reductant is recovered in the concentrating circuit and recycled with fresh carbon material. The ratio of recycled to fresh carbonaceous fuel is approximately 1.5 to 1.0.

In the process crushed ore is fed to the rotary kiln. The size requirements for a given ore depend entirely on the porosity and density of the ore. For certain ores a feed size of 1½ by 0 in. is adequate; in the case of a very dense ore it may be necessary to crush finer prior to feeding to the kiln. No sizing of the ore is required. Very fine concentrates may be balled prior to thermal reduction.

This provides for controlled combustion with an efficiency of approximately 75 to 80 per cent of the stoichiometric carbon requirement. Small quantities of limestone or dolomitic limestone, depending upon requirements, are fed into the kiln to arrest the sulfur contained in the ore, and in the solid carbonaceous fuel.

The solid fuel may be coke breeze, char, Disco, culm, anthracite fines and the like.

An extensive development program is being carried out in both the laboratory and pilot plant in evaluating fluosolids, grate and other types of charring units to be integrated with the kiln reduction step. Various types of high-volatile, low-grade carbon fuels will be tested in the pilot plant utilizing the hot gases to heat the charge through the burner end of the kiln, and using the hot chars produced as reductants. Commercial engineering projections have been made for such units. These indicate that low capital cost will be required. Furthermore, operating costs can be achieved which will result in significant over-all savings due to credit for gas produced.

The incoming charge which includes ore, limestone, solid carbon reducing material (coke breeze) absorbs heat from the combustion gases, and from the heated wall of the brick lined rotating kiln. The feed is dried, heated to calcination and reduction temperatures. The ore reduction proceeds from the outside of the ore particle toward the center, changing magnetite (Fe_3O_4) to wustite (FeO) and finally to metallic iron. The kiln may be fired with gas or oil. It is equipped with air tubes from inlets which are spaced along the length of the kiln to allow exact control of kiln temperature profile and composition of the atmosphere. Regular plant personnel and labor are responsible for operating the pilot plant. Of particular importance is the fact that the reduction is always conducted at a temperature below the melting point of iron and substantially all of the constituents contained in charge.

In the R-N Process, the desired temperature gradient, heat release and concentration of carbon monoxide (CO) throughout the kiln needed to perform optimum reduction functions is obtained by introduction of air for combustion at air tubes spaced along the length of the kiln. The desired temperature gradient or temperature profile and concentration of reduction gas is automatically and positively maintained throughout the kiln by this means. The general operating range of temperature used for reduction on a high grade ore is 1830° to 1970° F, with a mean temperature of 1950° F over about two-thirds of the kiln length. Other ores may require a different range. The temperatures and retention time in the kiln for any particular ore is guided by a time-temperature requirement established in laboratory testing on a representative ore sample.

Under proper operating conditions, the combustion reaction products are largely carbon monoxide, hydrogen and nitrogen and minimum quantities of carbon dioxide. Water and finely-divided carbon are also present. The reducing character of these gases emerging from the combustion chamber provides available fuel for combustion heating further along the

Table I

KILN OPERATING TEMPERATURE DATA

Thermo. No.	Dist. from Discharge End	Temp. of Gases, °F.
1	comb. chamber	1935
2	5′ 0″	1800
3	18′ 0″	1950
4	34′ 0″	1970
5	50′ 0″	1971
6	67′ 2″	1969
7	84′ 4″	1960
8	101′ 6″	1831
9	feed end	670
10	stack	512

Table II

COMPOSITION OF EXHAUST GAS

Kiln Exhaust Gas Component	Analysis %
CO_2	19.4
CO	0.4
O_2	0.8
H_2	0.9
CH_4	1.3

kiln. This permits the development of the long, high average temperature contour in the reduction zone, thus providing for the fullest possible reduction of the ore charge by the coke in the bed, under a predesigned temperature contour as shown in Table I.

The composition of the exhaust gas taken from the end of the kiln, prior to its mixing with the cooling air admitted through a thermostatically controlled port prior to the draught control fan, is given in table II.

The materials discharged from the kiln are cooled, either slowly or rapidly as requirements dictate. This maintains the iron in a passive condition to corrosion and thus effectively prevents reoxidation and loss of metal value.

The kiln discharge materials are separated by screening and gravity and/or magnetic separation. The excess solid carbon fuel is cleaned, dewatered, and returned to the kiln for re-use. The magnetic portion containing the reduced or metallized iron is freed of gangue by grinding, magnetic and gravity separation procedures.

Phosphorus and Sulfur Rejection High

The R-N beneficiation steps have several unusual features, which stem from the design of the process. The product of the kiln is not a magnetic oxide, which is often removed from ores by magnetic separators; it is basically metallic iron. This means that it has magnetic and gravity characteristics that make it readily separated from its gangue. Furthermore, a combination of magnetic and gravity separation provides flexibility in obtaining an optimum degree of over-all iron recovery and highest grade of product.

Phosphorus and sulfur in many ores may be rejected to the tailings by conventional procedures due to the mineralogy of the ore. One can expect that the efficient removal of phosphorus and sulfur will depend on the nature of the ore, its mineralogical structure, the size of lumps and other physical features of the materials, making up the furnace charge.

Phosphorus in iron ores may be present as iron phosphate and/or phosphates of other elements. Some examples of possible phosphorus minerals are as follows:

Iron-Bearing Phosphates

Vivianite, $Fe_3(PO_4)_2 \cdot 8H_2O$

Other Phosphates

Apatite, Ca_5 (F, Cl) $(PO_4)_3$
Collophanite, Ca_3 $(PO_4)_2 \cdot H_2O$
Wavellite, Al_3 $(OH)_3$ $(PO_4)_2 \cdot 5H_2O$
Wagnerite, (MgF) $MgPO_4$

When iron ore contains sufficient amounts of free oxides of calcium, magnesium, alkali metals, or when such free oxides can be formed during the process, e.g., by decomposition of carbonates, there is a good chance that stable phosphates of these elements already exist in the ore, or will be formed during the process and subsequently rejected into the non-magnetic fraction. In cases where the original ore contains more iron phosphate than can be bound by free oxides of calcium, magnesium, alkali metals or manganese, it is necessary to add free calcium oxide to the charge. In the R-N Process this is accomplished by additions of limestone or dolomite.

For solid-solid reactions such as

$$3\,FeO \cdot P_2O_{5(s)} + 3\,CaO_{(s)} = 3\,CaO \cdot P_2O_{5(s)} + 3\,FeO_{(s)}$$

it is important that the solid reactants are intimately mixed and that solid calcium phosphate or other stable compounds do not form diffusion barriers for the reaction. Rotation of the charge in the kiln, which is accompanied by mixing of the charge particles, may be, in many cases, sufficient to bring particles of calcium oxide in contact with the iron-phosphate-bearing ore particles and destroy the films of calcium phosphate. Volume changes accompanying the decomposition of hydroxides and carbonates and the reduction of iron oxide may also help in establishing an intimate contact between the reacting phases. The net result will be that iron phosphate of the ore is converted into calcium phosphate. The latter can be rejected into the non-magnetic fraction and discharged to the tailings.

Table III shows examples of phosphorus rejection.

Coke Used Has Considerable Sulfur Content

Sulfur in iron ores may be present as pyrites, sulfides or sulfates, as well

Table III

EXAMPLES OF PHOSPHORUS REJECTION

Ore	A	B	C	D
Total Fe	51.7%	61.1%	53.3%	31.0%
FeO	22.0	7.6	7.4	1.2
CaO	2.7	3.0	0.25	0.5
MgO	0.6	0.3	0.03	0.2
SiO_2	14.25	1.64	10.4	45.7
Al_2O_3	5.14	1.05	3.4	1.1
CO_2	0.32	1.10	0.3	0.25
S	0.02	0.01	0.03	0.10
P	0.68	0.58	0.07	0.06
R-N Iron Products				
Total Fe	95.6%	95.4%	94.0%	94.0%
FeO	11.8	8.4	7.8	18.2
CaO	0.3	0.3	0.2	0.1
MgO	0.6	0.1	0.3	0.1
SiO_2	0.97	1.00	1.6	1.5
Al_2O_3	0.50	0.36	1.5	1.1
S	0.03	0.02	0.03	0.03
P	0.07	0.11	0.035	0.05
P Rejection	94.4%	87.9%	71.6%	72.6%

Table IV

EXAMPLES OF SULFUR REJECTION

	Ore	R-N Iron	R-N Iron*	Ore	R-N Iron
Total Fe	57.4%	93.6%	93.6%	57.2%	95.9%
FeO	24.9	7.2	7.2	2.5	5.1
SiO_2	6.73	2.61	2.64	10.3	1.95
S	0.81	—	—	0.12	—
SO_4	2.27	—	—	1.20	—
Total S	1.90	0.19	0.04	0.52	0.07
S Rejection	—	93.9	98.7	—	92.0

*The ore was given an oxidizing roast prior to conventional R-N treatment.

as sulfates of calcium and other elements. Non-metallurgical coke or coal char used in the R-N Process has considerable sulfur content (up to eight per cent). The content of sulfur in the R-N product is in the range of 0.02 to 0.05 per cent. It is possible that part of the sulfur content of iron pyrite (FeS_2) and FeS is removed from feed materials in the preheating stage of the process by oxidation: e.g.,

$$FeS_{(s)} + 1\tfrac{1}{2}\,O_{2(g)} = FeO_{(s)} + SO_{2(g)}.$$

However, the amount of air entrapped in the feed material is not large, and the kiln atmosphere is relatively free of oxygen, so that most of the FeS should remain unreacted when it comes into the reduction zone. The oxidation of FeS by water vapor or carbon dioxide is not favorable thermodynamically and analysis of the kiln off-gas does not show SO_2 or other sulfur-containing gases.

In the reduction zone, sulfur from FeS can be transferred via the gas phase to free calcium sulfide by the following mechanism.

I. $FeS_{(s)} + CO_{(g)} = Fe_{(s)} + COS_{(g)}$
II. $CaO_{(s)} + COS_{(g)} = CaS_{(s)} + CO_{2(g)}$

From the free energy of Reaction I, viz.

$$\Delta F^\circ = +13{,}210 + 5.96T,$$

we find that $\log \frac{Pcos}{Pco} = -3.6$ at 1000°C.

The partial pressure of CO in the reduction zone at 1000°C is of the order of one atm. Therefore, the partial pressure of COS-gas over solid

FeS in contact with metallic iron (or with carbon) will be about 2.5×10^{-4} atm.

The free energy of Reaction II is

$$\triangle F^\circ = -24{,}400 + 1.15T$$

which indicates that the reaction is thermodynamically possible at all temperatures encountered in the kiln.

Two ores containing both sulfide and sulfate (partially weathered pyrite-magnetite) were successfully treated by conventional R-N treatment and 92 to 94 per cent sulfur rejection was obtained. In addition, the ore higher in both sulfide and sulfate was give a preliminary oxidizing roast followed by conventional R-N treatment. In this case, the sulfur rejection was 98.7 per cent. (See table IV). This indicates that a preliminary oxidizing roast may be beneficial in cases where the ore contains excessive amounts of sulfur. Such roasting may eliminate iron sulfide if it is present in appreciable quantities in the ore, and also lead to decomposition of iron sulfates.

Sulfates of calcium, barium and alkali metals are fairly stable compounds. If present in the ore, they will reach the reduction zone largely undecomposed. In the reduction zone, they will be reduced to corresponding sulfides which will be rejected into the non-magnetic fraction or to the tailings, or be partially leached during wet grinding and separation. Calcium sulfide can be removed in this manner. Iron ores containing large quantities of barytes have been treated by the R-N Process, resulting in a reduction of the barium sulfate to sulfide and its elimination to the tailings.

Metallic briquettes offer many advantages because of their uniform composition, high bulk density and good strength

Sulfur in solid carbon fuels has been evaluated and a large number of tests have been made with solid fuels (chars) containing two to five per cent sulfur. In every case, no difference in the sulfur content of the R-N product could be detected in changing from a 1.15 per cent sulfur content coke breeze to a high-sulfur, non-metallurgical grade solid fuel approximating seven per cent sulfur. It can be concluded, therefore, that the sulfur evolved from high-sulfur solid fuels should be completely controlled in the R-N- Process and should not enter the R-N iron product.

Table V

HIGH GRADE U. S. MAGNETITE ORE

Summary of Estimated Capital and Production Costs

Plant Capital Cost, Cost to Build in U. S. A. $17,000,000

Annual Production, Natural Gross Tons of Briquettes 400,000

Item	Units	Unit Costs $	Units per Nat. G.T. Product	$ per Nat. G.T. Product
Ore	G.T. dry	none	1.465	none
Carbon (in coke or char)	G.T. dry	13.00	0.368	4.78
Limestone	G.T. nat.	2.50	0.077	0.19
Fuel (natural gas or oil)	MM Btu	0.40	4.20	1.68
Electric energy	KWH	0.01	102.0	1.02
Water (make up)	M gal	0.10	0.200	0.02
Grinding balls & liners	$	—	—	0.06
Briquetting press (tools & dies)	$	—	—	0.11
Kiln relining allowance	$	—	—	0.20
All other maintenance (L&M)	$	—	—	1.68
Laboratory (L&M)	$	—	—	0.20
Direct operating labor	man hr	3.00	0.372	1.12
Supervision	man hr	4.50	0.064	0.29
Sub-Total				11.35
Depreciation & local taxes at 6.5%				2.73
Total Cost Above Ore				14.08

Typical Raw Materials and Estimated Product Analyses on this High Grade U. S. Ore

Percent by Weight

Item		Total Iron	Metallic Iron	SiO_2	Al_2O_3	S	P	Iron Recovery
Ore	(dry)	69	—	3.6	1.0	0.02	0.08	—
Product	(nat)	95	91	0.5	0.3	0.02	0.03	94

Extensive Tests Give Capital and Production Cost Estimates

The capital cost for an R-N Process unit designed to produce annually 400,000 gross tons of briquettes is estimated at $17,000,000. (See table V) This is based on a plant having four rotary kilns, each with an inside diam. of 12.5 ft and a steel shell 350 ft long, with all other equipment commensurate in capacity. No provision is made in the estimate for bringing utilities to the site. The estimate is independent of location within the United States and includes nominal site preparation to give an overall order of magnitude of capital cost. The estimate includes services, utilities, shops, offices and storeroom. Material handling of raw materials to the site and removal of waste from the site is included.

Production cost elements are provided in table V. Illustrative costs, using assumed commodity costs, are included to give an order of magnitude of costs above ore. For each ore it is necessary to perform adequate laboratory and pilot plant tests to more accurately project commercial plant costs.

Table VI is a comparative analysis of 4,000 tons of the high-grade U. S. iron ore fed to the rotary kiln along with the briquetted metallic iron product produced.

A total of about 2,000 net tons of metallic iron briquettes were shipped from the pilot plant at Birmingham, Ala., to the Chicago electric furnace plant of Republic Steel for melting tests. Early in 1957, 58 heats with varying percentages of R-N iron were compared with 58 companion heats using scrap to determine the differences in the melting performance as the percentage of R-N iron in the charge was increased. These heats were made in pairs, an R-N heat was followed by a companion scrap heat. The heats were made in various groups using 20, 30, 40, 50 and 60 percent of R-N iron in the charge. For reasons of brevity only, the data on the 30 and 50 per cent R-N iron heats have been omitted. The furnaces used in these tests were top charged.

The 2064 tons of R-N Iron received at the Chicago plant used in these tests had the analysis shown in table VII.

The cylindrical R-N briquettes had a mean diam of about four in. and a thickness varying from three to four in. They weighed from six to eight lb each and in the charging box they gave a bulk density of 225 lb per cu ft. Individual R-N briquette densities ranged from 5.7 to about 6.0. These physical properties approached the

densities of heavy bloom butt scrap as charged to the furnace. The R-N briquettes were shipped without special handling or preparation. They did not oxidize readily, though slight oxidation did occur in the presence of water when stored in large piles.

Heats were made in pairs, with the R-N briquette heat being followed by a standard scrap heat, as a base for comparison. The heavy R-N briquettes were layered between lighter scrap in the charging buckets to obtain uniform distribution of briquettes throughout the charge, avoiding any excessive concentration at any particular point, such as the bottom of the furnace or along the side walls, that might be detrimental to the melting. It was intended that these heats should be comparable so that the differences observed would result from the R-N briquettes used in the charge. The results are summarized in table VIII.

In table VIII, the heat times have been adjusted for operating delays because they abnormally increased these values. These delays were common to both regular and special heats. The delay adjusted to melt heat times at 20, 40 and 60 percent briquettes differs from the scrap heats by 0.15, 0.11 and 0.13 hr, indicating a negligible difference between the comparison and base heats at each level.

The charge to tap on R-N briquette heats shows a difference of 0.7 hr at the 20 percent level; 0.14 hr at the 40 percent level, and 0.59 hr at the level. Since the conditions at the end of the heat may not necessarily be related to the actual properties of the melting of the materials, charge to melt time is considered as being most significant and, in this regard, the results on R-N briquette heats and scrap heats were regarded as not significantly different.

In any experiment in steel melting, the probable value of the test usually turns out to be based on the experience and skill of the melt shop group. For that reason a bit of historical background of Walter Farnsworth, chairman of Republic Steel's Electric Furnace Committee is included.

Melting direct reduced iron was not a new experience to Farnsworth. He had melted imported sponge iron at Canton, Ohio, a generation ago. He melted the product of the Cape Brassert furnace which was operated in the Warren plant of Republic Steel during World War II.

The furnaces were not charged to maximum capacity to insure against spills. The boiling action of the R-N iron proved more useful than the friable Cape-Brassert briquettes. The melting characteristics of the heavier solid R-N Iron were much more satisfactory than the ordinary peach seed type of briquette.

Farnsworth's real criticism was that material weighing 225 lb per cu ft as charged was too heavy for fast melting if used in amounts exceeding 40 percent of the charge. Otherwise the product was useful in any routine steel melt shop.

Product Offers Many Advantages

In the U.S. steel industry, one of the surest ways to success with a new raw material is to provide something that can be handled in less time and with less care than the usual material. The present R-N metallic iron briquette with its high bulk weight and good strength permits easy handling and storage. Loading for charging either into buckets or boxes is equally favorable. The potential speed-up of operations pleased the melt-shop crews all along the line.

The uniformity of product both as to density and electrical conductivity made for surer operation, because no non-conducting spots were encountered. This is important where very heavy power input for melt down is used. The risk of power interruption and broken electrodes is nearly eliminated.

Where the composition of the material is known to be free from harmful incidental alloying elements, the melter need not wait for special laboratory analyses but may proceed with much more speed toward the completion of each phase of the operation. Freedom from dirt and contamination results in smaller slag volumes. Slag volumes are a problem even where molten pig iron is used due to the presence of the slag-forming elements such as silicon and phosphorous.

(Continued on page 56)

Table VI

ANALYSES OF KILN FEED AND BRIQUETTED PRODUCT

Component Determined on a Dry Basis Analysis	High Grade U.S. Magnetite Concentrate %	Metallic Iron Briquette %
SiO_2	3.56	0.54
Al_2O_3	0.96	0.27
CaO	0.36	0.41
MgO	0.22	0.18
S	0.014	0.022
P	0.08	0.030
Mn	0.06	0.05
Fe total	69.26	96.48
% Moisture	3.77	1.51

Overall recovery of iron—94%

Table VII

METALLIC BRIQUETTE COMPOSITION

Component of the Analysis	%
Iron	95.20
Metallic iron	87.98
Metallization	92.41
Carbon	0.28
Manganese	0.07
Phosphorus	0.029
Sulphur	0.019
Silica	0.51
Titanium oxide	0.57
Alumina	0.34
Lime	0.17
Magnesia	0.17

The total slag-forming materials in the above analysis approximate 2.75%.

Table VIII

SUMMARY OF OPERATING STATISTICS

	Group Averages					
	20%		40%		60%	
% R-N Briquettes	R-N	Comp.	R-N	Comp.	R-N	Comp.
1. Heat times* (hr) chg. to melt	3.53	3.38	3.95	3.84	4.02	3.89
2. Heat times* (hr) chg. to tap	4.47	5.17	4.94	4.80	5.05	4.46
3. Tons per hr* chg. to tap	19.9	17.1	18.4	19.0	16.5	21.1
*Note: Heat times and tons per hour have been corrected for delays.						
4. KWH per ton steel tapped						
chg. to melt	499	473	531	484	572	497
chg. to tap	543	562	576	525	617	527
5. Patching Time (min)	20	30	21	24	26	29
6. R-N charged (net tons)	18.0	—	36.3	—	57.4	—
7. Scrap charged (net tons)	73.3	94.0	56.8	93.5	34.2	94.7
8. Total metal charged (tons)	93.5	99.9	96.3	96.7	93.8	98.0
9. Total steel tapped (tons)	88.89	90.75	89.84	91.64	84.25	94.18
10. Gross Yield (%)	95.0	90.8	93.33	94.12	89.8	96.1
11. Carbon Charged (lb)	675	800	2269	738	3071	800
12. Melt-in carbon	.24	.52	.29	.26	.15	.32
13. Carbon tap	.18	.25	.23	.16	.08	.28
14. Lb of Ore/ton steel tap	52.3	152.4	58.8	80.5	38.4	59.1
15. Manganese: At melt	.18	.29	.15	.22	.12	.22
16. At tap	.16	.15	.14	.19	.10	.20
17. Ladle: Phosphorous	.010	.015	.012	.010	.009	.009
18. Sulphur	.032	.037	.030	.032	.027	.049
19. Total: (Incidental alloys)	.37	.42	.32	.38	.19	.41
Slag at Tap:						
20. % FeO	23.58	28.70	23.61	22.29	23.52	23.63
% TiO_2	1.38	0.55	2.61	0.57	3.97	0.59
21. Lb of Lime/ton steel tap	90.0	81.3	91.1	80.0	83.2	102.5
22. Slag at Tap: CaO/SiO_2 ratio	3.0	2.8	3.2	2.9	3.0	3.6

Performance Standards for Continuous Mining

In setting performance standards, it is axiomatic that perfection should be the goal. An engineer from a company with several years experience in continuous mining explains how equipment is rated and performance standards set

By D. C. HOWE
Superintendent, Vesta No. 5 Mine,
Vesta-Shannopin Coal Division
Jones & Laughlin Steel Corp.

IN January 1949 a Joy ripper-type continuous miner was transported underground into the Vesta No. 4 mine of Jones & Laughlin Steel Corp., and unloaded near the portal shaft. Probably every man employed in the mine, about 1300 at that time, found occasion to examine the machine and to venture an opinion as to its possibilities. When the miner was put into operation in February 1949, the question of its potential was not to be answered overnight. It certainly was too early to start thinking about performance standards. Everyone concerned was too busy trying to keep the equipment operating for a few hours each shift.

Maintenance Most Serious Limitation on Performance

In the nine years since that time, many problems involving roof control, ventilation, dust control, projection, and face transportation have been encountered and have been handled with some degree of success. Methods are now standardized in these particulars, although subject to change where it seems desirable. However, the most serious limitation on performance in 1949 is, even now, the most urgent problem. That problem, of course, is maintenance. The equipment still breaks down more than management thinks it should, despite very considerable improvements in design, in materials, and in maintenance procedures. The field of maintenance provides the most conspicuous area to gain further improvement in performance standards, using only the equipment the company now has. Certainly, new types of machines of different capacities and capabilities will make striking changes about which the company can only guess.

In order to establish performance standards it is necessary first to standardize the mining methods, mining projections, equipment to be utilized, and to gain a large measure of control over maintenance. Each area presents its own problems, and too often a procedure that solves one particular problem may create difficulties elsewhere. Infrequently there may be a choice of procedure, each alternative attractive enough to merit consideration. Coal mining, however, seldom enjoys this pleasant atmosphere, being subject to the dictates of safety, the law, and cost-demand factors.

Ripper-Type Machines Confined to Retreat Work

Let us take a glance at several of the problems that have arisen during Jones & Laughlin's gradual move to continuous mining during the past eight years. Each has had an important affect on the maintenance situation. Probably the first obstacle to be encountered was the difficulty the machine had cutting and handling drawslate. The Vesta mines are in the Pittsburgh seam and have five to six ft of mineable coal above which is a fairly uniform drawslate about one ft thick. This drawslate is often very hard, and is especially so in development work. The first ripper-type miners the company obtained could not stand the burden of handling this material in solid work. Bits, cutting chains, and bar drive mechanism had alarmingly short life.

After some rather frustrating experience in development, the machine was moved to the first butt entry in a new panel and put to work retreating a butt entry by driving under the drawslate, leaving head coal four to six in. thick. The top was supported with 5 by 7 in. wood crossbars set on four-ft centers. This system worked out very well in the first butt entry, and the machine itself, relieved of the stress of mining drawslate, held up with more success. However, in the second and all successive butt entries, the drawslate could not be held because of roof pressure from the adjacent gob area. The weight of drawslate and a few inches of headcoal is sufficient to brake 5 by 7 in. crossbars, once the initial strength of self-support has been lost.

Although roof pressure prevented further mining under drawslate, it, at the same time, eliminated the difficulty in cutting the drawslate. The coal seam adjacent to the gob often is crushed to the extent that a miner operator need make only a part of the shear to bring down both the coal and the drawslate. Cutting conditions of this nature, locally described as "cabbage coal", are ideal for the ripper-type machine. These early experiences promoted a decision to confine the use of available continuous miners to retreat work as much as possible. Even today, with 25 ripper-type machines in service, Jones & Laughlin does not have enough continuous miners to supply the required tonnage; therefore, the machines are used for development work in the Vesta mines only when it cannot be avoided.

Maintenance Cost Increases in Development Work

Many improvements have been made in the 3JCM miners and in the cutter bits since the company's first experimental work which now permit the use of the machines for development mining. In addition, the Shannopin mine has nine Joy ICM continuous miners in service. This is a more powerful, more rugged machine and in average or better cutting conditions it can be used for development

Donald C. Howe's experience includes five years with Pittsburgh Coal Co. in various engineering and production departments, and 11 years with Vesta-Shannopin Coal Division, Jones & Laughlin Steel Corp. He has served J & L in such capacities as time study engineer, assistant mine foreman, head of Industrial Engineering Department, mine superintendent and mining industrial engineer.

mining without excessive maintenance trouble. It can be expected, however, that the cost per ton for maintenance supplies will pyramid when a machine is used for development work as compared to retreat work. The bit cost per ton also can be expected to increase from about $0.05 for retreat work to about $0.25 for development work for average conditions and has been known to go over $1.00 in extreme cases of difficult cutting in development work.

The relative advantages and disadvantages of full recovery as compared to partial recovery must be carefully weighed in the process of setting performance standards. Assuming that roof conditions are about equal, partial recovery systems almost always show greater machine productivity than do full recovery systems. On the other hand, very important economic advantages may accrue on a long-term basis from a full recovery plan. In our case, the coal from both J & L mines is of metallurgical quality and is located relatively close to the mills near Pittsburgh. Further, both mines have openings adjacent to the Monongahela River so that the considerable savings of transportation by waterways can be realized. Under these circumstances, full recovery has been the objective at both mines for many years.

Timber and Roof Bolts Used

Successful full recovery is a matter of continuous and rapid movement. Roof conditions have often handicapped the company in achieving this continuous and rapid movement. Roof control methods have been a subject for intensive study. The continuous miner itself has been a major factor in achieving roof control in retreat mining. Its use permits the limiting of working places to one per machine and so enables the maintenance of a fracture line in any outline or at any angle desired.

The company has tried roof bolting with continuous mining, along side, ahead, in back of the machine, and in an adjacent place. It has been found, insofar as retreat work is concerned, that timbering is quicker, safer, and cheaper. Timbers usually provide enough advance warning of an imminent roof fall to enable expedient removal of equipment from the working place. Roof bolts do not provide this warning. Timbering is less expensive; first, because equivalent roof support can be put in place with less delay to the machine, and second, because part of the material can be recovered and used in the next lift as mining progresses.

Roof bolting has been used with great success, however, in most of our entry development with both conventional and continuous mining equipment since 1949. The problem of using roof bolting in conjunction with continuous mining, in our roof conditions and without interruption of production, is one which as yet has not been solved. Probably the nearest approach to a solution is embodied in the six Joy ICM ripper-type continuous miners with mounted hydraulic roof bolt drills now in service at Shannopin mine. In other cases, the company has tried, or is using, stopers or hydraulic drills of a number of different types both as separate equipment or mounted on the continuous miner, on the surge car, or on a special conveyance.

Interdependence of Components on Continuous Mining Section

Combining continuous roof control with continuous mining is certainly a necessary forward step and represents a challenge to everyone in the mining industry. Our Joy ICM miners with mounted roof bolt drills have had a fair measure of success as long as all components are in working order. However, when one drill is down, the whole unit is paralyzed until repairs can be made or until timber supplies can be moved to the face. This matter of the interdependence of the components on a continuous mining section is one which has been given much of management's attention recently.

It is apparent, for each additional machine put to work on a given section to operate in an interdependent way with other machines in order to produce as much coal as possible, that the over-all percent of downtime for repairs must increase. No machine is breakdown proof. If, at the same time, the operating problems become more complex, as is usually the case, the improvement in productivity must be great enough to overcome these factors and still show an appreciable net gain, else the use of the additional equipment cannot be justified.

It has been our experience that things can get too complex for the average face boss or the average mechanic to keep under control. Just how much additional equipment can a company put into a given area and expect a six or seven-man crew to keep everything operating, greased, and oiled, to say nothing of doing some preventive maintenance. In addition, machines are becoming more and more complicated. They cost more, because of all the new gadgets, and the parts cost more, and there are more of them to stock which is an item of great importance.

Job Tickets Provide Valuable Information

Setting performance standards for continuous mining requires accurate knowledge of the loading rate of the miner in various conditions of cutting. This information readily can be obtained from time studies. What will prove equally important is an accurate analysis of downtime for various reasons, especially for repairs and for non-productive work such as timbering. In a move designed to gain the required knowledge of repair times and delays and also an idea of how section mechanics are occupied during the shift, J & L several years ago initiated a system of job tickets to be filled out by each mechanic. On this job ticket mechanics detail how they spend their time, using coded work symbols, and giving machine numbers involved. In the event of a breakdown, the delay time caused thereby is detailed. These job tickets are countersigned by the crew foreman who is required to make a separate report of his own covering all delays encountered for all reasons. From these job tickets has come a variety of valuable information that can be used to set performance standards, to set up maintenance controls of many types, to establish schedules for major repairs and overhauls, and to provide a comparative analysis of one section in relation to the others.

A complete tabulation is made each month for each unit of all the job tickets. Our continuous miners are losing about 11 percent of available work time because of breakdowns. The available work time averages seven hours per machine shift. Management feels, by elimination of certain obvious mechanical weaknesses in the equipment and by application of a standardized preventive maintenance program, that it can reduce the lost time from breakdowns to possibly six to eight percent of available work time. It should be pointed out that the data is based on very complete information covering triple-shift operation of 22 machines usually five days per week. There is no give or take in the analysis. If a machine lost an entire shift due to a breakdown, and no spare section was available, a full shift is charged as delay in the records.

Even before the company found it was losing 11 to 12 percent of its available work time because of equipment failures, it had become apparent that the maintenance program had to be given much more consideration. Certainly, one obvious course to pursue to help improve the performance of available equipment lies in reducing delay time due to breakdowns. A number of moves have been made in that direction, including maintenance educational programs, increasing maintenance forces and maintenance supervisory personnel where it seemed necessary, making spares more quickly accessible, changing design and construction to eliminate weak points of the machines, and instituting a program of planned rebuilding. It was some consolation to read a recent paper dealing with another

continuous mining machine operation that reported 25 percent lost time due to mechanical and allied delays.

Repairs to Miner Average 25 Minutes Per Shift

Our records for a six month period show that the continuous miner was down for repairs for an average of 25 minutes per shift. Where the machine was serviced by two shuttle cars, an additional outage of 16 minutes was experienced; if a car hoist was used, two minutes more was lost. Sections using extensible belts had an average 13 minutes outage due to the belt. Sections using roof bolt drills mounted on the continuous mining machine lost five minutes per shift for repairs to the drills.

What particular parts of the equipment are causing the most lost time? The job tickets show this in detail:

Hydraulic Hoses, Continuous Miners—
17% of Total Lost Time
Cables, Shuttle Cars—
15% of Total Lost Time
Discharge Conveyor Chain, Continuous Miners—
13% of Total Lost Time
Electrical Controls, Continuous Miners—
10% of Total Lost Time
Front Conveyor Chain, Continuous Miners—
8% of Total Lost Time

The calculation of performance standards can be reduced to a fairly mechanical operation once the basic factors have been delineated and evaluated. Analysis of time studies indicates that a Joy 3JCM or ICM can produce 1.4 tpm of raw material in development work in average cutting conditions in the Pittsburgh seam in our locality. In retreat work, the production rate increases to 1.6 tpm of raw material. It will be noticed that these statements of operating rate are qualified by circumstance and location. The company has heard and read of far higher producing rates in other operations.

Performance Standard Equals 410-500 Tons Per Machine Shift

In setting performance standards, it is axiomatic that perfection should be the goal. It is more practical to make an accurate estimate of the several factors which prevent full utilization of paid work time and which cannot be eliminated for one reason or another. One of these factors is portal time or travel time. It can be reduced but it cannot be eliminated. There is an economic limit to the number of portals which can be provided. Compliance with State and Federal laws, and the dictates of safety not spelled out therein, acts to prevent full utilization of available work time, where available work time is defined as the time the crew spends at the face. In this connection, the influence of opinions of State and Federal inspectors, in matters not defined by law, cannot be disregarded.

When the limitations of available work time, of maintenance, of the mining method, and of the equipment itself have been brought into focus and have been minimized, the performance standard in terms of tonnage becomes readily available. For our circumstances, the calculation resolves to about 410 tons per machine shift for development work with timbers and about 500 tons per machine shift for development work with roof bolting. For retreat work with timbers the standard is 460 tons per machine shift. It is realized that there are many operations where these production rates can be exceeded because of more favorable conditions. The speed of mining is notably affected by the ease or difficulty in cutting the coal.

Basic performance standards must be adjusted to fit existing conditions for each individual section. This matter of adjustment can be involved and can arouse dissention, because, basically, it becomes a matter of opinion. If the methods and ratings used to set the standards are kept as simple as possible and are understood by all concerned, any program based on performance standards has a much better chance of succeeding.

EUROPE AND THE U. S. COAL IMPORTATION ISSUE

(Continued from page 33)

organizations can hope to regain a bigger share of the market. But once a factory's furnaces have been converted to oil, this consumer is gone for good.

ECSC Coal Gap Forecast— 48,000,000 Tons

Despite the coal glut, the European coal industry is continuing programs to expand production. The Ruhr hopes to boost total German production to around 180,000,000 tons by 1978.

The ECSC's High Authority reports that despite the soft coal market, Europe's coal and steel industries will spend more in investment projects this year than in any previous postwar year. The ECSC envisions a six-nation total coal production by 1960 of 258,500,000 tons—as against a coal requirement of 306,000,000 tons.

This leaves a coal gap of nearly 48,000,000 tons, according to ECSC estimates. While the Ruhr coal lobby in Bonn presses for the curbing of American coal imports, the domestic industry is doing its long-range planning on the basis of the ECSC coal gap forecast.

Ruhr seams are narrow, twisting and difficult to work with mechanized mining

Planning and Scheduling

MAINTENANCE

By J. A. VITZTHUM

Supterintendent-Maintenance
Oliver Iron Mining Division
United States Steel Corp.

The old routine of considering all jobs as emergencies and doing the work first for those who yelled the loudest has been superseded by an orderly and planned maintenance program. The results: higher shop efficiency, reduced inventories, less high cost jobs, better use of personnel and increased cost consciousness

The company's shops carry on all phases of repair and maintenance work, from the manufacture of parts to complete overhauls of major units. Pictured is a diesel locomotive being brought into one of the modern Eastern District shops for repairs

OLIVER Iron Mining Division of United States Steel Corp. consists of three separate operating districts located on the Mesabi Iron Range in northern Minnesota with general offices located in Duluth, Minn. Oliver's primary function is the mining and beneficiation of both natural and taconite iron ores from open pit operations.

The subject of this article is planning and scheduling of maintenance as applied to open pit mining and beneficiating equipment. Since this includes both open pits and plants, the list of this equipment is quite long and varied, and there is no intent to enumerate all of it. To better portray the maintenance problems involved however, perhaps it will help to briefly list the major categories of equipment in the two classifications.

Open pit equipment includes several makes and sizes of both diesel and electric powered shovels, diesel electric locomotives and locomotive cranes, stripping cars and flat cars, speeders, several makes of blast hole drills, crawler and rubber tired tractors, 34-ton capacity diesel powered trucks, road graders, sprinkler trucks, mine buildings and other allied equipment.

Plant equipment includes various types of crushers, pug, rod and ball mills, pan and belt conveyors, magnetic separators, vibrating screens, sintering and nodulizing equipment and miscellaneous auxiliary equipment.

Under normal conditions, the author's particular district of Oliver employs from 1600 to 2000 men. Roughly one fourth are maintenance department personnel who are divided into craft and non-craft classifications. The crafts include electricians, carpenters, painters, masons, sheet metal workers, blacksmiths, machinists, welders and pipefitters. The non-craft group includes gas and diesel automotive mechanics, locomotive, drill and shovel maintenance mechanics, maintenance mechanics general, and stripping car repairmen.

The maintenance facilties consist of centrally located shops; electric, carpenter, blacksmith, machine, car repair, truck and tractor garage, locomotive, welding and general repair. These shops carry on all phases of repair and maintenance from the manufacture of parts to complete overhauls of entire major units. In addition to the central shops there are certain field, or area garages and shops which perform running repairs and service work on mobile equipment. This information is provided in the interest of background and to illustrate the fact that the scope of work in the

Jobs are not scheduled into the shops until all estimated supply requirements are fulfilled. This practice greatly improves shop efficiency and prevents duplication of costly parts. The men shown here are putting the finishing touches on a diesel engine after a complete overhaul

various shops involves a highly variable work load of a non-repetitive nature.

Planning and Scheduling Program Installed

Efficient mining practice requires a well organized maintenance program. The effectiveness of a program can be expressed in a number of ways, but usually it is measured in dollars. Reduction of maintenance costs, therefore, is one of the prime objectives of the Maintenance Department. There are many things that can be done to realize this goal and one of them, in Oliver's case at least, was to install a maintenance planning and scheduling program. Prior to the installation of the program about 2½ years ago, however, considerable research was necessary to determine which of several such programs available would best suit the company's requirements, and also to obtain information with which management could be convinced that the program would be economically advantageous.

Oliver wanted to start the program off with three planning and scheduling analysts and proposed to enlarge the group to five at some later date. One of the best arguments for the program was that three of the top notch workmen from three different classifications could be selected to act as planning and scheduling analysts, without replacing them in their respective shops. It was felt very strongly that they would be of more value in the new functions than in their previous jobs, and that the good they could accomplish would more than offset their loss as productive maintenance workers. Three of our best men were selected: one from the auto mechanic group, one from machinist group and one from the electrician group. These three men, augmented by two clerks, the part time services of a draftsman and headed by a mechanical engineer, became the planning and scheduling organization.

The Planning and Scheduling office is a maintenance control center that plans, coordinates and assists the operation of all shops. Major types of work accomplished by this office include: (1) work order control; (2) keeping maintenance records and equipment files, and (3) the various engineering services of design, cost and procedures. Work order control and analysis, however, forms the greater part of this work. The work order system was instituted in order to increase shop efficiency and stimulate shop coordination by planning repair work and the required sequence of operation and by eliminating wasted or unproductive work. The operation of the system is standardized requiring each work order to follow established procedure.

Preliminary Work Improves Shop Efficiency

Any foreman can originate a work order request for needed repairs within his responsibility. However, his immediate superior, usually the mine or plant superintendent or his assistant, must approve the request before it can be submitted. Upon receipt, the Planning and Scheduling office checks each request to insure that it has been approved, that there is an adequate description of the work to be done and that all accompanying parts are properly tagged. The request is then given to one of the three work order planners who initiate a work order for each shop involved which indicates the sequence of operation and the proper cost codes to be used for charging out the work as it is accomplished. Work orders are then reviewed in respect to estimated cost of labor and material required. Warehouse stocks are checked to determine which of the required parts or materials are on hand and these are earmarked for the specific job. For any parts or supplies required but not on hand, the work order planner contacts the proper warehouse personnel to get them ordered and earmarked for his particular job. This is an important phase of the planning and scheduling work because jobs are not scheduled into the shops until all estimated supply requirements are fulfilled. This greatly improves shop efficiency over the previous method of taking work into the shops, dismantling, determining and ordering, if not on hand, the required parts and supplies and leaving the job unfinished until such supplies were received.

When these details have been completed and if the project is within the approval authority of the Maintenance Department, the work order is copied in triplicate and both labor and supply cards are printed in advance so that all costs will be charged according to the proper cost codes and work order number. Any other information pertinent to the work that may be available in parts files or past records is also attached to the work order to assist the shop foreman in planning his work. At completion, all supply and labor costs charged to the work order are compiled on IBM machines with one copy being furnished the originator of the order and another being retained in Planning and Scheduling office records for analysis and future control and reference. Also, for management information, a summary of costs by work order number and description is provided.

The procedure described above applies particularly to the operation of the "Craft" shops as requested by mines, plants or other shops. Field maintenance shops or garages, however, working on direct repairs to mobile equipment, do most of their work without a work order, since inspection service and other preventive maintenance is charged to the using responsibility by equipment number. Major parts replacement or general overhaul and other work beyond the scope of preventive maintenance must have a work order due to the high cost of such work. Certain limitations have been placed on repair costs for various classifications of equipment and these limitations cannot be exceeded without the approval of a General Office appropriations committee.

Established Routines Pinpoint Source of Trouble

Another function of Planning and Scheduling is the development of proper preventive maintenance

routines such as inspection service and lubrication schedules. The work planners, by analyzing repair jobs, frequently find that certain parts are being replaced or repaired more often than would normally be expected. This of course leads to an investigation as to the cause which, in many cases, turns out to be either lack of lubrication or improper lubrication. Pointing such things out to operating supervisors, and issuing proper lubricating schedules or instructions to them and their equipment operators, ordinarily will correct this situation with resultant reduction in maintenance costs. Analysis of repair jobs and costs may occasionally turn up certain design weakness in equipment. When this happens, the subject is taken up with the manufacturer of the equipment and in most cases the manufacturer is very cooperative and willing to correct such weakness in order to improve their product. Still another advantage of repair cost analysis is the ability to compare each job with the the advance cost estimate and with similar jobs done previously. If there is any wide variation, the cause is investigated to determine whether the reason lies with the estimate or job performance. As the number of similar repair jobs recorded in the files increases, the more reliable the data becomes, and future estimates and control will become more accurate. All of these factors play their respective part, even though it may be small, in the continuing battle of reducing maintenance costs and increasing the effectiveness and efficiency of both maintenance employees and facilities.

Many Other Important Advantages Realized

The Planning and Scheduling program has greatly reduced the clerical requirements on both supervisory and skilled maintenance employees, leaving them more time to perform the primary duties. It has also provided more reliable and accurate cost data due to the preprinted labor and supply cards which almost completely eliminated errors in basic reporting. Much wasted work and lost effort has been weeded out of all the shops and, in the case of the machine shop at least, the problem of over production of manufactured parts has been brought under control. Prior to Planning and Scheduling many cases occured in which work was taken into the machine shop, dismantled, and repair parts ordered. Quite often the job became urgent and parts were made rather than wait for the ones on order. Then when the ones on order were received, they had to be taken into stock, as the job was already completed, with resultant surpluses in inventory. This has now been practically eliminated because when the job is planned, the urgency of completion is determined and parts to be manufactured are scheduled accordingly so that duplication of both purchase and manufacture does not occur. This ties in very closely with the statment made previously that jobs are not scheduled into the shops until all estimated supply requirements are on hand.

One phase of planning and scheduling which was comtemplated, but which was not put into effect, was the actual scheduling of work on individual major machine tools in the machine shop. Work is scheduled into the shop as in all other shops, but not for the individual machine tools. It is hoped that the program can eventually be expanded to include this phase of work scheduling as it will further increase shop efficiency and permit a larger percentage of supervisory time to be spent on supervision instead of on internal shop planning. Generally speaking, experience has shown that the greater the detail of prior planning, the less burdensome each job is for shop supervision and the more smoothly the work flows through the shops. The old routine of considering all jobs as emergencies and doing the work first for those who yelled the loudest has now been superseded by a much more orderly and planned routine. At the start of the program there was some difficulty in convincing operating personnel that each job requested did not have to be an emergency which had to be completed at once. This was an educational problem, however, and the maintenance department now gets good cooperation from all operating departments. Operators have found that they can get much better shop service at lower costs if they plan their work and shop requirements in advance. Emergencies still occur and always will, but provision has been made to take care of them accordingly. With improvements in the preventive maintenance program, more and better advance planning all along the line, we find that the frequency of emergency jobs is steadily decreasing and maintenance costs are decreasing proportionately. The ideal situation would be to eliminate all emergencies and be able to plan and schedule 100 percent of all maintenance personnel and shop time. This goal can never be reached, but the company is striving to get planned maintenance time up into the 60 to 75 percent range and will be quite pleased to accomplish this much.

One more aspect of a well organized planning and scheduling program is the fact that the backlog of work orders for each shop provides a very good guide for estimating both immediate and future manpower requirements. This can be a big help in stabilizing manpower, leveling out peak requirements and determining when and how much work to contract to outside firms in order to avoid crewing up for temporary conditions.

The foregoing report covers just the highlights of Oliver's maintenance planning and scheduling program as space will not permit any more detailed coverage. In conclusion, the program definitely has been beneficial: (1) it has increased shop efficiencies; (2) weeded out wasted or unnecessary effort; (3) helped to reduce inventories; (4) provided better and more reliable maintenance cost data than was previously available; (5) minimized emergency high cost jobs; (6) helped to determine manpower requirements, and (7) made many more people much more cost conscious than had ever been before. Oliver can definitely recommend the installation of a similar type of program to any operating company that does not already have one, and especially to those interested in controlling and reducing their maintenance costs.

All emergencies can't be eliminated; however, Oliver is striving to get planned maintenance time up into the 60 to 75 percent range

A greater demand for coal . . . an inefficient loading shovel . . . an ever-lengthening pit haul—these were problems facing management in its attempt to streamline mining operations and increase efficiency. Larger haulage units and increased storage capacity remedied the situation and provided other advantages

Haulage Developments at ENOS

By WILLIAM C. LAIDLAW
Production Engineer
Enos Coal Mining Co.

THE efficiency of the modern coal preparation plant is affected by the feed of raw coal to the plant. An even, uninterrupted flow of raw coal assures the operator a consistent marketable product, less coal in the refuse, and more tons produced per man hour.

When the present Enos Coal Mining Company's preparation plant was designed and constructed, a 1000-ton raw coal hopper was incorporated to minimize delays. This storage was ample under original expectations. However, later additions and improvements increased plant capacity 25 percent and the advantage of the raw coal storage was decreased a like amount.

To meet this greater demand for raw coal an auxiliary loader was pressed into constant service. The Enos haulage fleet proved insufficient to meet the greater demand for coal because of time lost at an inefficient loading shovel and an ever lengthening pit haul.

To remedy this situation management considered two possibilities:

1. **The acquisition of additional loading and haulage equipment.**
2. **Increased utilization of present equipment by enlarging storage facilities.**

Storage Capacity Increased by 3000 Tons

Enos operating personnel had always desired additional storage facilities, but studies proved them to be an economic luxury. With the additional problems, however, careful analysis indicated that these facilities could very well remedy the situation and provide other advantages. It was felt that the raw coal storage would best translate the operations of all independent mining units into a continuous flow of coal to the preparation plant. The greater utilization of a smaller number of haulage units allows for quicker depreciation and retirement to take advantage of the rapid advancement in design of haulage trucks. Pit operation and management would also be simplified.

Two methods of storage were considered; open and contained. The latter was chosen because of limited space available and ease of reclamation.

W. C. Laidlaw has been employed by Enos Coal Mining Co. as time-study engineer and production engineer for 16 years. Prior to this he served as project engineer for the Indiana State Highway Commission.

Truck garages and storage bins. Note the storage belt conveyor which transfers the 6 in. by 0 coal to a terminal point over the storage bins. From this point, the coal can be distributed by remote controlled chute to the two storage bins by delivering half or all of the coal to one bin or to a horizontal belt conveyor over the bins, which in turn delivers half or all the coal to the second bin

It was estimated that an additional 3000 tons of storage capacity would be necessary to eliminate preparation plant downtime and insure improved continuity of pit operations.

To minimize size segregation it was preferred to limit the top size of stored coal to six in. by storing coal after it had passed through the rotary breaker. To divert the minus six-in. coal from the existing raw coal circuit to the new storage system, it was necessary to revamp the collecting hopper under the rotary breaker. Coal from this hopper can be discharged into either the raw coal belt conveyor to the preparation plant or to the new storage belt conveyor.

The storage belt conveyor transfers the 6 in. by 0 coal to a terminal point over the storage bins. From this point the coal can be distributed by remote controlled chute to the two storage bins by delivering half or all of the coal to one bin or to a horizontal belt conveyor over the bins which in turn deliver half or all the coal to the second bin.

The storage bins are constructed of curved corrugated steel sheets reinforced with structural members. Each bin is 40 ft in diameter and 51 ft high with a combined capacity of approximately 3000 tons. A concrete slab supports the bins and also roofs a concrete tunnel below. A remote controlled reciprocating plate feeder under each bin delivers 200 to 600 tons each to the reclaiming belt which returns the coal to the collecting hopper under the breaker.

Operational control of the storage system is integrated with the main plant control system through the use of a dual control arrangement whereby the operator at the main plant control panel can control all reclaiming operations of the storage system. The reclaiming units may also be controlled from the primary control center in the rotary breaker building.

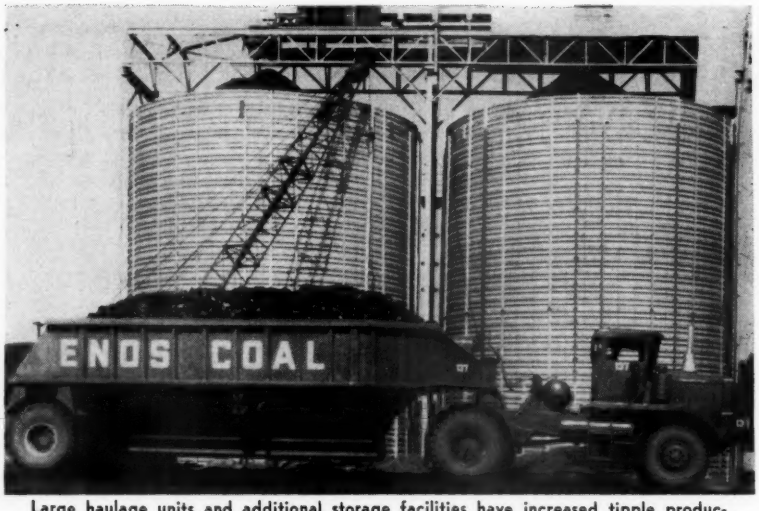
Raw coal for the main plant may come from the dump hopper, from either or both of the storage bins, or in a blend from all storage facilities.

All conveyors are 48 in. wide belts operating at 500 fpm. Conveyors are protected from the weather by hinged corrugated galvanized steel covers.

Three 61-Cu Yd Trucks Replace Six Smaller Units

Further advantages of the increased storage were derived by replacing six 44-cu yd tractor-trailer units with three new 61-cu yd units. The six smaller units operating one shift provided 264-cu yd of haulage capacity. With the storage bins in operation the three 61-cu yd units operating two shifts provided 366-cu yd capacity.

The three new units acquired were Autocar A.P. 25 tractor-trailer units. These trucks are powered with Cummins turbocharged engines developing 335 hp at 2100 rpm. The exhaust gas-driven turbocharger provides 35 additional horsepower by eliminating power loss of gear driven superchargers.



Large haulage units and additional storage facilities have increased tipple production 600 tons per shift

Transmission consists of an Allison TC-570 torque convertor combined with an Allison CT-5640 transmission in one unit. This combination eliminates exterior oil lines and simplifies installation and maintenance. The TC-570 torque convertor is equipped with lockup clutch and torqmatic brake. The CT-5640 transmission provides four speeds forward and two reverse for greater range and better splits. Power is transmitted to the rear axle by a heavy drive shaft to eliminate vibration and whip.

The planetary-gear type rear axle incorporates several new engineering features. The ring gear and planetary drive pinions are free to float endwise to eliminate end loading of gear teeth. The center of load line is located equally between wheel bearings to provide greater stability and bearing life. New axle design also facilitates use of 15-in. rims to give better flotation, more stability, and longer tire life. The number of wheel lugs has been increased to a maximum to prevent working.

Brake design includes two 5-in. brake shoes in each wheel unit to provide greater lining area and longer brake life. The anchoring of one brake shoe forward and one back allows equal torsional loading on brake drums and enables the use of two brake chambers, cams, and slack adjusters for greater braking effort.

Improved design front axle allows 3½-in. additional ground clearance. A 95¾-in. track provides full 35° turning angle both right and left. The continuous flow of hydraulic oil through power steering cylinders is prevented by the use of pitman arm stops to close valves at the end of travel.

Front and rear radius rods are equipped with ball and socket ends to eliminate binding. Radius rods are adjusted by use of shims.

Torsional rigidity characteristic of the box-section frame is maintained by internal corrugated reinforcement. The frame is of all welded construction with internal stresses relieved by heating after assembly.

The radiator is a built-up unit with separate upper and lower tanks, side brackets and core to simplify repairs. Channel sections welded to frame assembly protect radiator and frontal area.

Cab is mounted in an off-set position to the left to maintain full driver comfort while shortening the wheelbase. The steering column can be moved up and down in a range of two in. and can be moved forward and backward over an arc of 15°. Two cowl and two roof ventilators are provided.

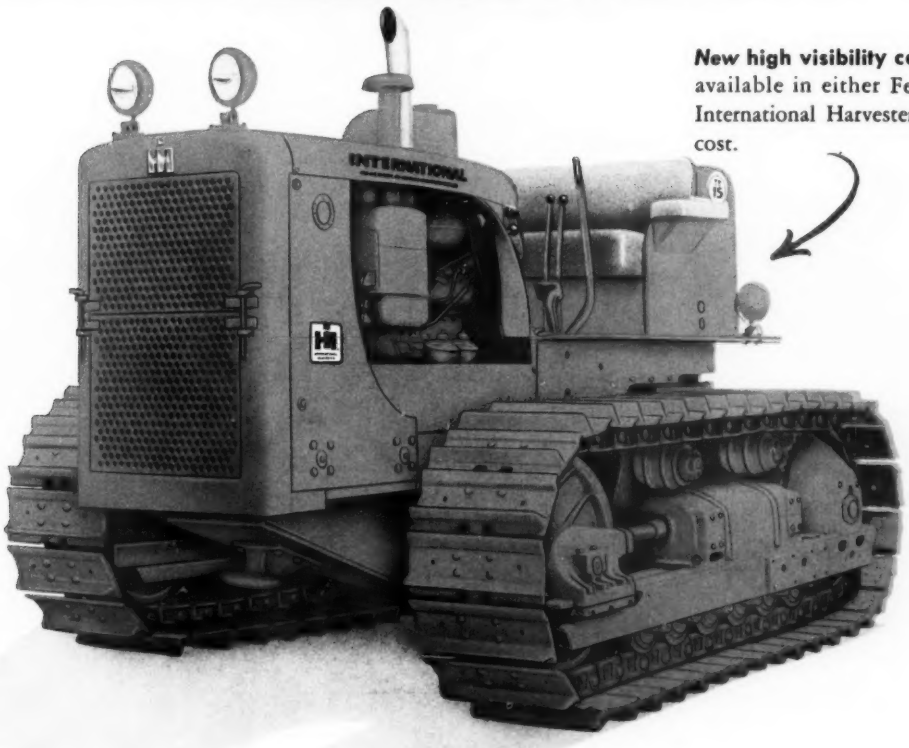
The trailer is of built-up construction with end slope sheets and side hopper plates reinforced by angles and supported vertically at each end by corner posts. Doors are clam shell type operated by a ten in. diameter cylinder on each door. The trailer axle is identical to driving axle except for moving gears and center section. The trailer hitch is fitted with nylon bakelite bushings throughout.

In comparison, the Autocar A.P. 25 tractor-trailer units are now hauling 15 percent larger loads than similar units powered by 300-hp Cummins engines through Allison TC-564 torque convertors and TC-602 transmission with 13 percent less fuel. The speed, loaded and empty, has been increased.

The complete new set-up, storage and haulage units, has reduced tipple down-time to a minimum.

NEW International® TD-15 tops 100-hp field...

with exclusive power and control features!



***New* high visibility color.** Optionally available in either Federal yellow or International Harvester red at no extra cost.

NEW

6-cylinder diesel power . . . 105-hp fully-proven D-554 engine—full 20,500 lbs drawbar pull.

NEW

6-speed full-reverse transmission...20% higher reverse speeds. A speed for every work or travel need plus fast "Shuttle-Bar" direction changing!

NEW

Precision control

Foot Decelerator for instant speed changes —fast "Shuttle-Bar" forward-reverse travel.

NEW

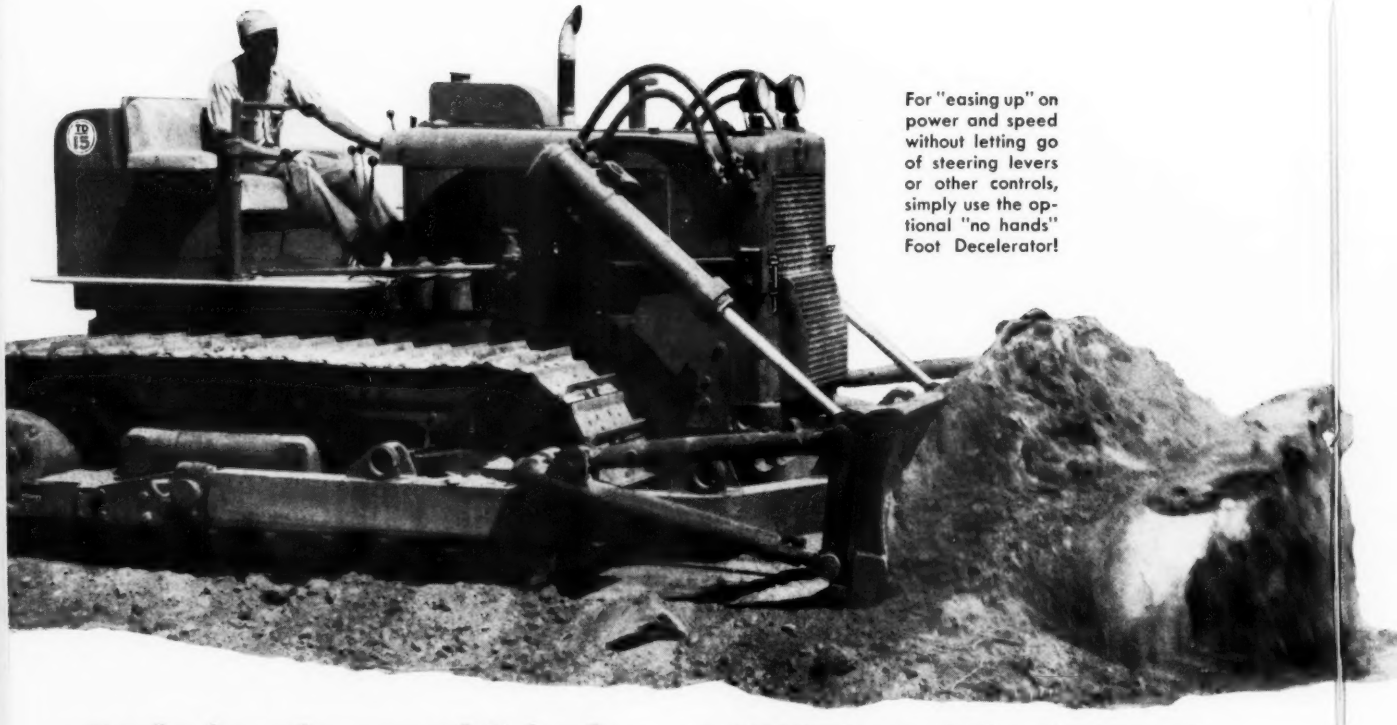
1,000-hour lube interval, heavy-duty track rollers

. . . heavy-duty, long-life bushing type, with extra capacity lube reservoir.

...and here's the pay-off for you...

You move in on...and speed up

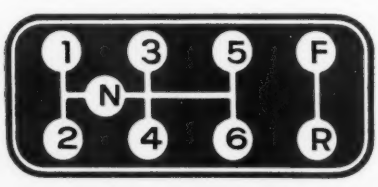
....with NEW TD-15



For "easing up" on power and speed without letting go of steering levers or other controls, simply use the optional "no hands" Foot Decelerator!

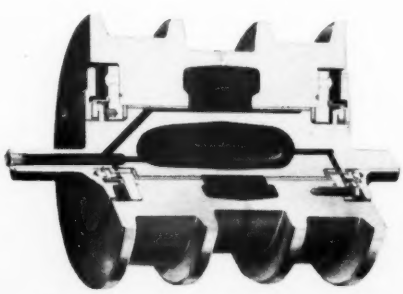
Exclusive six-speed "single stick" shift... forward and reverse "Shuttle-Bar"

You shift through all six speed ranges of the new TD-15—forward or reverse—with a single lever. Shift pattern is planned for gear-changing ease and speed with a fast sweep of the hand—to give you instant use of the speed you need. To speed the work-cycle and take full advantage of fast shifting, you simply push or pull the "Shuttle-Bar"—to change TD-15 forward or reverse instantly.



1,000-hour lube interval, heavy-duty, track rollers

Not just another "claim" . . . International now combines heavy-duty *bushing design*, exclusive cartridge-type *metal-to-metal seals*, and king-size lube reservoirs, to offer the industry the first heavy-duty type roller as standard equipment on the TD-15. Thick shells for safe build-up and exclusive pressure relief passages for flush-out and prevention of seal damage from power lubricators are part of this new design.



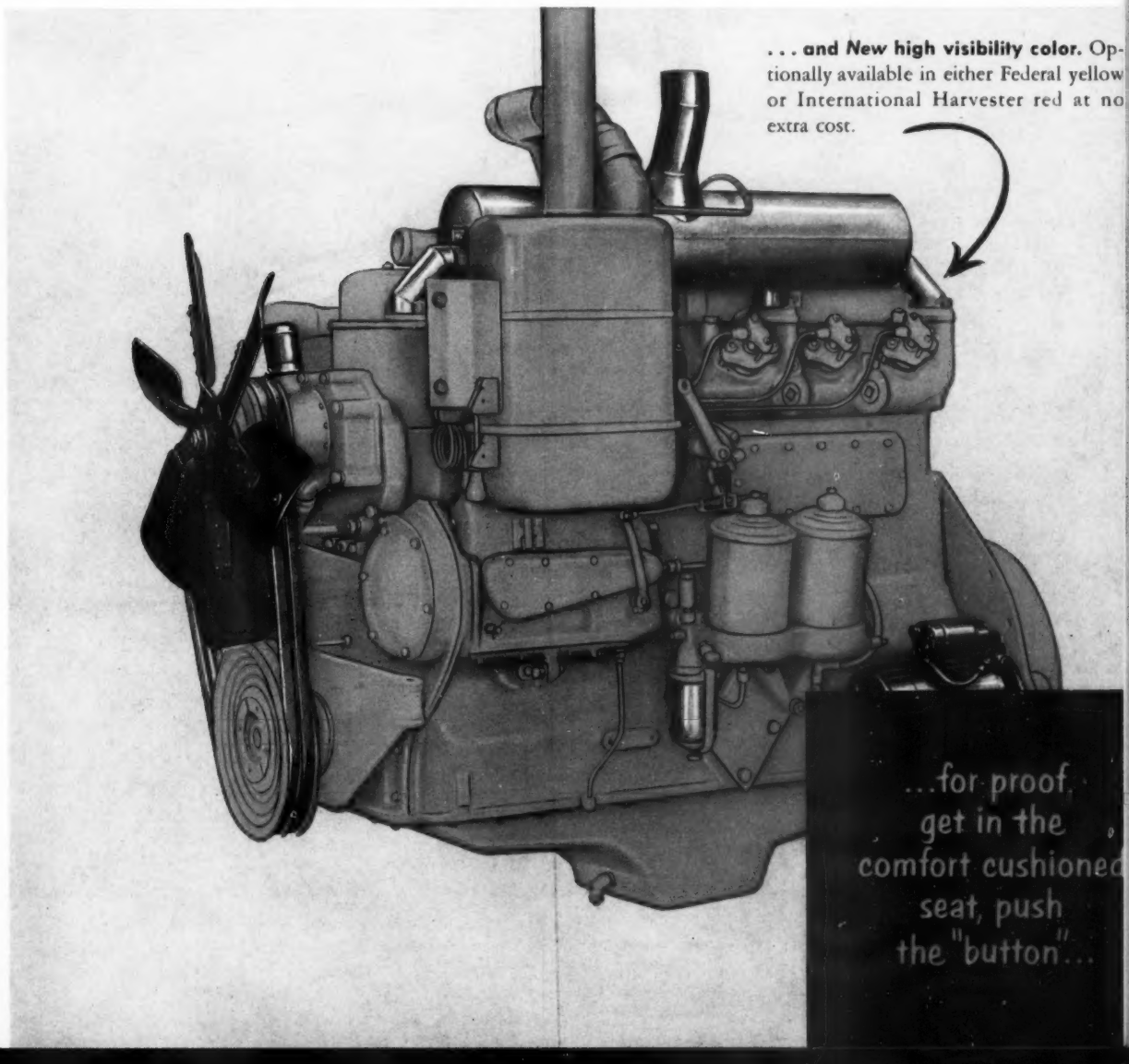
...a whole new range of jobs...

capacity and control

Smooth 6-cylinder... BIG 105 IH diesel horsepower

You get 6-cylinder smoothness from this new International D-554 diesel engine that powers the new TD-15. This fully-proven power plant produces its 105 net hp at 1,650 rpm . . . features famous International 45-degree angle operation full-flow lubrication, closed pressurized cooling, exclusive twin plunger pump fuel injection system, fully counter-balanced crankshaft, positive valve rotators, and all-weather gasoline conversion starting. Here's an engine built for long life, big-capacity output!

New power, strength, control, and reliability features like these show you how and why the 105-hp TD-15 tops its field. You move in on a new range of heavy jobs—material-moving, land-clearing, hauling, loading, excavating, logging, mining—that no longer belongs to next-size-bigger crawlers!



. . . and *New* high visibility color. Optionally available in either Federal yellow or International Harvester red at no extra cost.

...for proof, get in the comfort cushioned seat, push the "button"...

Compare TD-15 performance to anything *in the 100 hp crawler field!*

Prove to yourself you can move in on, and speed up, a whole new range of heavy jobs—with new TD-15 capacity and control. Put the TD-15 through its paces—compare *power*, *speed*, *capacity*, and *control* to anything else on tracks in the 100 hp field. The 6-speed full-reverse transmission and "Shuttle-Bar" will show you on-the-job how fast, easy, and profitable shuttle-cycle operations can be! Press the decelerator and see what a helper this feature can be for actually speeding up operations—by reducing declutching and shifting time! Measure sintered metal, dry-type clutch full power transfer efficiency and maintenance, ease and economy to any other crawler's clutch—wet or dry! See your International Construction Equipment Distributor for a new TD-15 demonstration!

International® **Construction Equipment**

International Harvester Co. • 180 N. Michigan Ave. • Chicago 1, Ill.

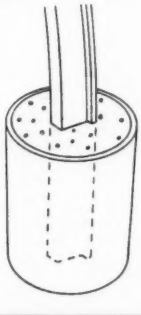
A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers and Bottom Dump Wagons . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

Questions

We've been asked about the Yieldable Arch

"What kind of base or footing should we use with the Yieldable Arch?"

If the bottom of your drift is definitely firm, you can set the Arches directly on the rock itself. Otherwise you should set them on footings. Wood blocks are frequently used for this purpose; so are short pieces of steel plates, channels, I-beams or other steel "leftovers."



If an acid water condition exists in your mine, it's well to set the Arch legs in concrete. A short length of pipe will serve as a permanent form in which to pour, as shown in the sketch.

SEND US YOUR QUESTIONS

You probably have other questions of a specific nature, concerning the application of the Yieldable Arch or Ring to your mine. If so, by all means send them in; we will study your questions and reply as promptly as possible. Write: Room 1041, Bethlehem Steel Company, Bethlehem, Pa.

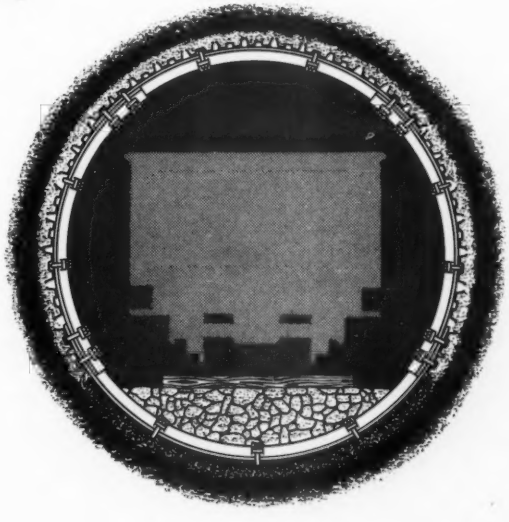
"Our mine opening has a heaving bottom. Is there any way the Yieldable Arch can help under that condition?"

For problems such as bottom heave, Bethlehem can furnish a four-piece yieldable set which is really not an arch but a Yieldable Ring, with four joints instead of the usual two found on the conventional Arch set.

The Yieldable Ring is essentially similar to the Yieldable Arch. It works on the same principle of sliding joints, is made of the same U-shaped sections, and is available for the same range of mine openings. It provides the best means of operating under pressures squeezing in from all directions.

Installation of the Yieldable Ring differs in that the two joints at the bottom of the ring should be tightened only to about 150 ft-lb, instead of the 180 ft-lb of torque normally applied. This is due to the fact that the bottom two joints usually will lie in muck, which adds measurably to the friction in the joint.

One more important point: with the Yieldable Ring, as with the Arch, lagging and blocking is necessary to fill the voids between steel and rock. Lagging should *completely surround* the Yieldable Ring.



BETHLEHEM STEEL COMPANY, BETLHEHEM, PA.

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BETHLEHEM STEEL

FREEZING for Shaft Sinking at PCA

Freezing or grouting—which method is more efficient and satisfactory for ground stabilization in areas where unconsolidated, water-bearing formations are encountered? Here are two votes for freezing

By JOSEPH B. CUMMINGS

Admin. Assistant in Charge of Exploration and Development, and

RUSSELL G. HAWORTH

Vice President in Charge of Production
Potash Company of America

THE presence of the salt beds in the Canadian basin was first indicated by churn drill holes drilled near MacMurray, Alberta between the years 1907 and 1910. However, little was known of their lateral extent—into Saskatchewan, Manitoba, northwestern North Dakota and northeastern Montana—until after 1940. In 1943, a well drilled near Radville, southeastern Saskatchewan, produced core in which potash was definitely recognized at a depth in excess of 7600 ft. Because of the great depth of the discovery, any interest from the standpoint of mining was ruled out. However, it did serve to stimulate sufficient interest to bring about a more careful inspection for the presence of potash during subsequent drilling—particularly at wells where the salt was penetrated at a much more shallow depth.

Potash Company of America's interest in the Canadian salt basin dates back to early 1947, after the discovery near Unity, Saskatchewan of a potentially favorable potash bed at a depth of approximately 3500 ft. It was announced in 1951 that Western Potash Co., a company formed to develop the deposit near Unity, was conducting experiments for the extraction of this deposit by brining. This proved to be infeasible, and in 1952 a shaft was started which was at a depth of about 1500 ft when operations were discontinued.

In the latter part of 1951, Potash Company of America conducted rather extensive field investigations in Alberta, Saskatchewan and Manitoba consisting of examination of core and other data obtained by oil and gas exploration in the basin. After assembly and study of these data it was decided in early 1952 to commence a core drilling program for exploration of the area in Saskatchewan, extending from near the Manitoba border to a short distance east of the city of Saskatoon. This work was continued until early in 1954.

In the course of the above exploration program, coring and drill stem testing of formations overlying the

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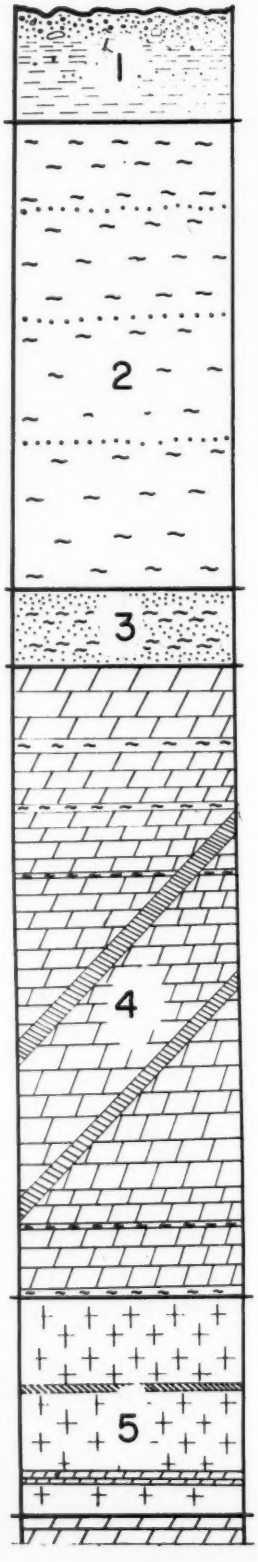
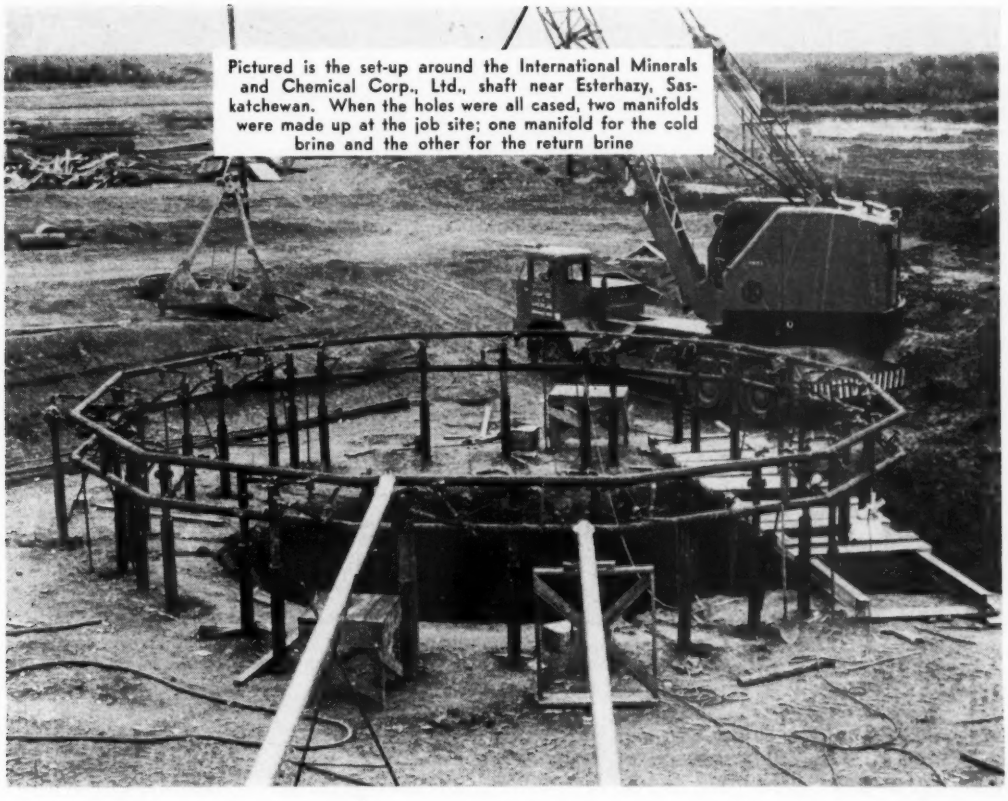


A generalized geologic column at Potash Company of America's shaft location, 16 miles east of Saskatoon, Saskatchewan shows the following: 1. GLACIAL DRIFT—clay, sand, gravel and boulders; 2. SHALE—with interbedded sandstone; 3. SANDSTONE—SHALE—with sand; 4. DOLOMITE—with anhydrite, limestone; argillaceous, dolomitic and calcareous shale; 5. EVAPORITE—salt, potash, anhydrite and dolomite. Several formations are water-bearing: the sand formations have hydraulic pressures ranging up to 800 psi



Pictured is the set-up around the International Minerals and Chemical Corp., Ltd., shaft near Esterhazy, Saskatchewan. When the holes were all cased, two manifolds were made up at the job site; one manifold for the cold brine and the other for the return brine

at IMC

By FRANK C. PICKARD

Project Engineer
International Minerals & Chemical Corp. (Canada), Ltd.

and

GILBERT H. DUBY

Shaft Manager
Utah Company of the Americas

THE site of the potash mining operation under construction by International Minerals & Chemicals Corporation in Saskatchewan, Canada, lies in the pond-dotted southeast corner of the prairie province and is underlain by a geological section with definite high-water-bearing problems.

Pumping tests on two wells in the area, near the town of Esterhazy about 120 mi east of Regina, indicated that either of two water-saturated gravel zones in the first 300 ft could develop about 5000 gpm in the 18-ft shaft to be constructed in the IMC operation.

This paper will describe the freezing method of ground consolidation used to overcome these problems and sink the shaft successfully through the 300-ft section of glacial drift.

First Costs High, But Method Is More "Positive"

How to achieve this objective was the subject of thorough study and led to a considerable review of ground consolidation methods which had proved successful in other operations.

Considered and rejected was the method of pumping with the accompanying use of liner plates. Grouting with cement and chemical compounds was also studied but decided against.

Freezing, higher in first costs but known to have been successful in other shafts where similar conditions existed, was finally selected—chiefly for the reason that it was a more positive method. It was also felt, on the basis of pre-sinking studies, that costs would not be prohibitive because freezing probably would not be necessary below the glacial till.

Lewis Refrigeration Co. was called in to design and supervise installation of the freezing system.

The final freezing plan, evolved after extensive planning discussions with contractor and IMC personnel in charge of the project, called for 30 freezing points to be put down in a circle 32 ft in diameter with the points on 3.35-ft centers.

This pattern of freezing points was decided upon after consideration of a number of requirements, including:

1. **A time schedule which called for the ice wall to be frozen within 25 days**
2. **Necessary allowance for drift in the drilling**
3. **Prevention of ice or freezing in the shaft proper, which would impede actual excavation**
4. **Keeping to a minimum the costs of drilling and placing the freezing points**

Location of Freeze Holes Precisely Controlled

Actual drilling of the freezing point holes, done by a contractor with two 2500 Failing rotary drills and cone type bits, presented various difficulties.

Because of sand and other loose

(Continued on page 55)

(Continued from page 52)

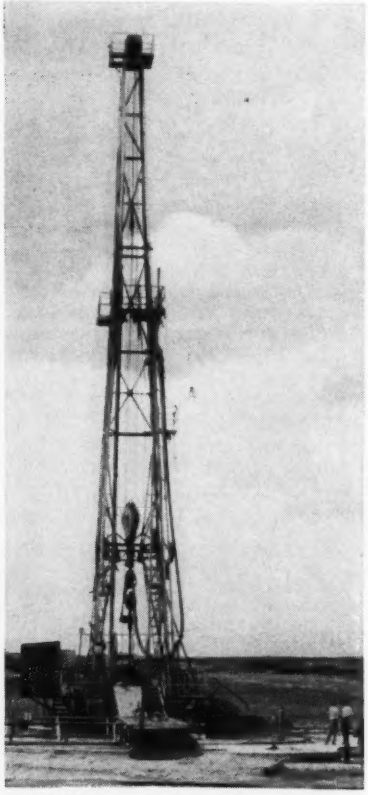
potash deposits were done to obtain information relative to shaft sinking conditions. As a result of this work, with consideration being given to other major economic factors, including availability of power, fuel and labor supply, the site located about 16 mi east of Saskatoon (population approximately 80,000) was selected.

Traverse of Water-Bearing Formations Requires Freezing

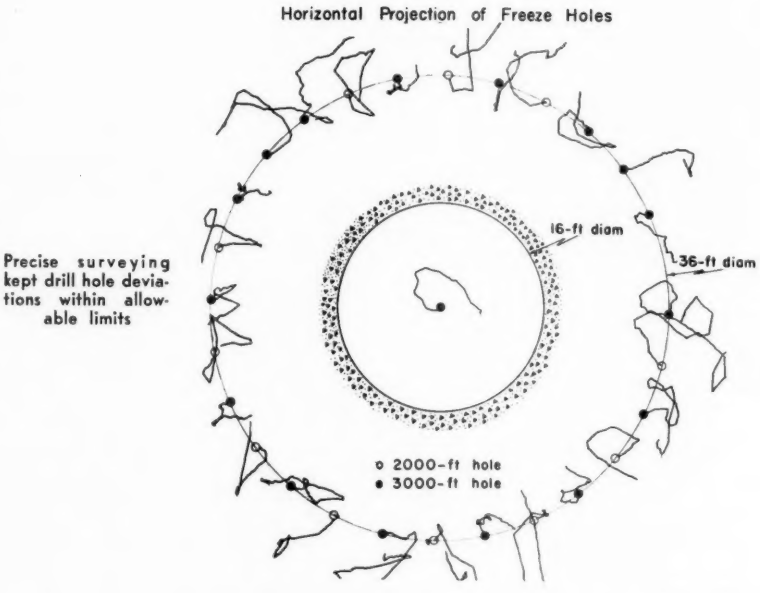
In general, the formations overlying the deposits, in sequence from the surface downward are:

1. **Glacial drift; a heterogeneous formation consisting of clay, sand, gravel and boulders in which some strata are water-bearing**
2. **Shale with interbedded sandstone**
3. **A sand-shale and sandstone member throughout which there are several strata containing brine and unconsolidated sands**
4. **Dolomite, dolomitic, argillaceous and calcareous shale, and anhydrite, the upper part of which contains substantial quantities of brine**

Prior to final selection of the Saskatoon area as the best area for operations, coring and testing of the formations above the salt were carried out. Unconsolidated sands and loosely consolidated sands interbedded with shales and sandstones were found in the Blairmore formation. The sand formations were water-bearing with pressures ranging up to 800 psi. The glacial drift at the surface was also water-bearing as were several formations in the lower limestones. It was decided to freeze to 3000 ft in depth in order to guarantee success in sinking. Furthermore, the shaft was to be heavily lined with reinforced concrete, with ample allowance for full hydrostatic pressures that could develop in the sandy formations.



One rig, with a capacity in excess of 5000 ft, was employed throughout the entire program, and a smaller 3000-ft capacity rig was added after the job was 50 percent complete



Precise surveying kept drill hole deviations within allowable limits

Drilling Program Totals More Than 76,000 Ft

The freeze ring was accomplished by drilling 27 near vertical holes, spaced about four ft part, around the circumference of a circle having a diameter of 36 ft. These holes provided a means of circulating a coolant at below freezing temperature to a depth of 3000 ft. In addition to the freeze holes, an observation hole approximately 40 ft from the center of the shaft, and a hole at the center of the shaft were drilled to depths of 3000 ft.

The holes were drilled with standard oil-gas rotary drilling rigs—one rig, with capacity in excess of 5000 ft, was employed throughout the entire program, and a smaller 3000-ft capacity rig was added after the job was about 50 percent complete. In Europe, where the freezing method for shaft sinking originated, churn drills have been used for this type of work.

Casing was set through the glacial drift and cemented to the surface at all holes. This was done to facilitate drilling, inasmuch as the formation consists of unconsolidated material. Upon completion of drilling, each freeze hole was cased with closed end pipe to prevent the coolant solution from penetrating the formations. After all holes were completed, smaller pipe was installed in each hole for the descending coolant solution, which ascends through the annular space.

Directional surveying instruments were used throughout the entire program. The procedure in surveying being to take readings with a single-shot instrument at 30-ft intervals (maximum). Readings were taken more frequently when more than the maximum allowable deviations (15 to 20 minutes) occurred, and corrective measures were being taken to straighten a hole. Upon completion of each hole, a check survey was run, using multi-shot surveying equipment.

The drilling program, including drilling slightly in excess of 76,000 ft, running casing and tubing (with headers provided), required 681 rig days.

800-Ton Refrigeration Plant Used

The refrigeration plan, consisting of two Freon-12 centrifugal systems, each with a capacity of 400 tons, was put in operation in August 1955, and shaft collar excavation was commenced.

Temperature recording was accomplished by use of thermocouple measurement through a central control panel located in the refrigeration plant. Each freeze hole was equipped with a minimum of two thermocouples, one near the top and one near the bottom of the hole.

The center-shaft and observation holes, as well as two of the freeze holes opposite the observation hole, were equipped with several thermocouples placed at various intervals for the purpose of determining vertical temperature gradient and estimating thickness of ice wall at several horizons. Temperature indicating equipment was also provided at the intake and discharge ends of the cooler.

Centrifugal pumps were employed for circulating the coolant through the cooler and to the holes. Separate lines served for transmission of the coolant from plant to the shaft collar, and separate headers were used for distribution of the flow to the 2000 and 3000-ft holes. Return to the plant was by a single line via a 3000-gal surge tank.

The flow circuit was designed for regulation of flow to the 2000 and 3000-ft hole feed lines, and provision was made for regulating the flow at individual holes.

Shaft Lined With Reinforced Concrete

Shaft sinking was commenced in February 1956, upon completion of surface installations including construction of headframe and installation of hoisting facilities consisting of the production hoist, which during shaft sinking was used for muck removal, and a smaller hoist for handling the working stage (after production commences, this to be used for handling men and materials).

Progress in sinking the first 180 feet of the shaft was relatively slow, because until this depth was reached there was not sufficient space to allow for installation of complete permanent sinking equipment. In June 1956, this equipment, which included working stage, complete grab mucker control and traversing mechanism and drilling jumbo, was installed, making it possible to carry on sinking and lining operations concurrently.

The shaft was lined with reinforced concrete to the top of the salt. Sectional steel forms and base ring were used, these being designed by the company engineers, as was most of the sinking equipment. Concrete was batched in a plant located near the collar of the shaft and transported to the collar in truck-mounted mixers where it was dumped into a hopper and dropped down the shaft in a pipe.

In June 1958, the shaft was completed to final depth of 3450 ft, and presently mine development preparatory to production is under way.

The concentrating plant is almost completed and it is anticipated that before the year's end the plant will be placed in operation on development ore.

In conclusion, it can be said that sinking shafts by the freezing method is expensive and many problems are encountered. It may also be said that, to date, it is the only proven, positive method of sinking through quicksand beds where high water pressures are present.

Grouting methods and materials available are also improved and it remains to be determined whether freezing or grouting proves to be the most efficient and satisfactory method. In the not too distant future we will know more in this regard.

PICKARD AND DUBY

(Continued from page 53)

material encountered in the area, it was necessary to use drilling mud to consolidate the walls of the holes. In the two water-bearing zones, round rocks of igneous material six to 12 in. in diameter deflected the drills and made extremely close drilling control necessary in these areas.

Sperry-Sun Well Survey Co. directed this phase of the operation and it was executed successfully, with the help of special well surveying instruments to measure the bearings and inclinations of the bore holes. Measurements with the instrument, a magnetic, directional, single-shot device, were made at close intervals, the frequency depending on conditions encountered.

The instrument consists of (1) photographic lights operated by a circuit breaker; in turn, controlled by a timing device; (2) a carrying frame to hold batteries, lens, and a loading chamber for a sensitized film chart; and (3) a magnetic compass unit.

To get a recording, the timing device was first pre-set for the length of time it would take to get the instrument down and positioned in the area to be checked. Then the instrument, encased in a non-magnetic casing, was lowered into the drill pipe and positioned in a non-magnetic drill collar.

At the pre-determined time, the current circuit was closed by the timing device to light the photographic lights. The reflected image of the compass card, indicating degree and direction of hole inclination, was carried to the sensitized chart by the lens system and registered there to be developed and studied above ground.

The results of each record were used to determine the weight and rpm to be applied to the bit to keep the hole on course.

Because of the frequency of inclination surveys necessary (more than 1000 were taken in the drilled holes), the time required for such work loomed as a factor of considerable magnitude when translated into lost rig time.

Use of every possible time-saving device was imperative, and none was overlooked. The timed circuit breakers were perhaps most important in this direction. In addition, a special developing process and a fast film were employed in preparing the photographed chart records. Accessory equipment used with the instrument permitted direct insertion of the sensitized chart, as well as its removal for developing, in daylight. Developing

Freezing points consisted of 1½-inch plastic pipe inside three-inch Schedule Forty pipe. Cold brine entered the smaller pipe and was returned through the annular space

time, interpretation, and decisions on weight and rpm were usually all completed by the time the crew had prepared the rig for drilling after a survey.

As a result of time-saving efforts and devices employed in making the more than 1000 surveys, it is estimated that drilling time lost (calculated as time elapsed from breaking the Kelly to putting it back on the drill pipe) amounted to only 25 hr. Equally significant, only about 15 reruns were required and none of them because of instrument failure.

Because of the unusual closeness of the drill holes used for this freezing system—7⅞-in. holes put down with an average spacing of 3.35 ft between centers—it was necessary to put a check against the findings of the survey instrument used.

This Sperry-Sun instrument, a type thoroughly satisfactory in ordinary drilling, was developed for use on holes with very small inclination from the vertical. The holes drilled in this operation had an average angle of about 20 minutes, and alignment factors played an important part in the reading given by the survey, and in determination of the projected course of a hole based on that reading.

Such alignment factors were: (1) the clearance required to insert the instrument into the protective casing; (2) the guides used to center the protective casing in the drill collar; (3) the bore of the collar itself, and finally (4) the positioning of the vertical axis of the collar parallel with the vertical axis of the hole.

Since these factors assumed magnified importance with holes as close as these, and required extremely limited tolerances, a method of checking the single-shot records by use of a multi-shot photographic recording was employed. By a method of positional changes with the multi-shot these misalignment factors were averaged out.

The survey of the points when completed showed that in some cases the drift had caused an opening between points up to six ft. This necessitated drilling and placing four additional points.

Calcium Chloride Brine Used for Coolant

The finished holes were cased with Schedule Forty three-in. diam pipes, pretested on the surface. The bottom of the casings were closed by welded plugs. When the holes were all cased, two manifolds were made up at the job site (see photos); one manifold for the cold brine and the other for the return brine. The freezing points themselves consisted of 1½-in. pipe inside the three-in. pipe. To reduce the cost of the job, 1½-in. plastic pipe was used here—an innovation—and it proved to be completely satisfactory. A gland was fabricated at the top of each freezing point.

The refrigeration plant itself consisted of three ammonia compressors, each with a capacity of 49 tons of refrigeration at 25 psig suction. Each compressor was driven by a 75-hp motor. Initial plans for a well to supply water for the condenser were abandoned in favor of a spray pond, to avoid possible water movement in the stratum to be frozen.

Two shell-and-tube brine coolers were installed, designed to operate with a terminal temperature difference of six degrees Fahrenheit. Calcium chloride brine of 1.25 sp. gr. was the coolent, and two pumps circulated a total of 700 gpm against a total head of 60 ft, 20 ft of which was in the brine coolers. The brine system included a brine make-up and surge tank.

The freezing proceeded on schedule, exceeding expectations to a slight degree. Brine temperatures, which initially disclosed a range of approximately five degrees, gradually decreased over a thirty day period to a range of less than two degrees.

Thermocouples were not installed, since the water-bearing sand was 200 ft below the surface. Instead, temperatures were read off the freezing points and calculations were made from the tonnage applied to determine how much freezing had taken place.

This system worked very well and no leaks developed during freezing and actual sinking of the shaft.

No Major Difficulties in Sinking and Concreting

Sinking was started as soon as the manifolds had been completed and freezing was actually in progress. A 30-ft excavation was made, and this section and the collar were poured. Sinking to a depth of 120 ft was uneventful and no ground freezing was apparent in this area, which was above the water table. Entering the static water table, it was found that a good ice wall had been formed, although the shaft excavation area was not frozen. Sinking proceeded without interruptions until the first major water bearing zone was encountered, and here the freezing had been completed across the shaft.

Care was taken to shoot this frozen material very lightly to prevent breaking the freeze pipes. Only the two water zone areas, each approximately 18 ft in depth, were frozen solid and the balance had the ice wall as originally calculated.

The refrigeration plant was operated until the shaft was through the glacial drift and 20 ft into the underlying shale, and was then shut down. No effort was made to accelerate the thawing around the shaft, as it was felt that any sudden change might be detrimental.

To date, the material around the shaft is still partially frozen and the shaft is practically water tight, although it was found necessary to grout behind the shaft lining at one cold joint where the rubber water seal, in all probability, was not properly placed.

Concrete poured against ice, as in the two solidly frozen zones, presents no problem, probably because recrystallization generates enough heat to melt the ice directly in contact with the concrete. In this area, an 18-in. concrete wall was used and the concrete was not affected.

IMC's experience indicates that freezing was the best consolidation method for this area and was an entirely successful operation. The cost for freezing, drilling and operating this plant when spread over the glacial drift section of the shaft amounted to $575 per ft. It was felt, after studies had been made, that it would not be necesary to freeze below the glacial till.

In conclusion, the authors feel that freezing is a positive method of consolidating zones containing high volumes of water. Careful planning is required, and the freeze holes must be controlled when they are being drilled.

The authors wish to thank Robert E. Lucas and Quinton B. Marsh for their assistance in preparing this information.

DIRECT REDUCTION OF IRON ORES

(Continued from page 38)

The R-N metallic iron briquette has a real advantage for the melter and this was quickly recognized in the gentle boil on melt-in which insured even bath temperature and action, so useful in fast-working furnaces.

The comments of the supervisors, melters and furnace men were very favorable. While recognizing the fact that the present size and shape could be improved upon, they generally said, "Send us more."

The author would like to acknowledge appreciation of the assistance of the men at the Southern Mine Spaulding operation of Republic Steel and National Lead, and to the U. S. Bureau of Mines personnel at Boulder City, for their contribution to the success of this project. In addition, he is indebted to Earle C. Smith, Ben McCrackin, Don E. Babcock, Walter Farnsworth, Ray J. McCurdy, Wade Weaver, D. Leckie and W. A. Callendine of Republic Steel, and John Breitenstein, R. P. Smith, and Lee Stuart, of R-N Corp., Peter Robertson of Republic Steel, P. W. Bakarian of R-N, and Dr. H. K. Work of New York University are due a special thanks for their help and cooperation and permission to publish this paper.

MODERN APPROACH to Equipment Maintenance

An effective maintenance program must stress rigid inspection, preventive maintenance, and periodic or scheduled overhaul

By RALPH B. DEAN
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Lorado Coal Mining Co.

THE trend in coal mining continues for more and more production to be mechanically loaded or conveyed from the face.

Changes in mining practices brought about by mechanization have been readily accepted by management because they have made possible greater production at lower cost.

The philosophy of many companies seems to be that higher tonnage affords some sort of "built-in equalizer" that will automatically compensate for increasing costs of production. It is unfortunate that there is a point of diminishing return when increasing the output of tonnage under this criterion of management.

It is true that every expense incurred in the production of coal is influenced by the rate of production, but to increase production by one percent or any other percent is useless in acquiring greater income if expenditures rise in the same proportion.

It is also extremely difficult to recover from unexpected increases in money spent or tonnage lost during the remaining work days of any given month.

Mechanization has been a contributing factor in bringing attention to bear on the problem of equipment maintenance. This is true for at least two good reasons:

1. **The realization of a fair return on the heavy investment in mining equipment dictates that it must be kept operational at all times to meet the production demands.**
2. **Under hand loading systems a breakdown in a piece of equipment resulted in a loss of production, but with mechanical mining, idleness on a section caused by machine breakdowns not only causes a loss in production, but adds the wages of the idled men to the mine cost.**

Emphasis in Past on Production

It is a known fact that primary emphasis in the past has been put on production, and not until recently have supplies, "back-up" labor, and maintenance received the attention they deserve by virtue of their importance to the profit and loss statement of any company.

Lorado Coal Mining Co. has an industrial engineering program that has been in effect for seven years. In its initial stages effort was concentrated on production by establishing the best way of doing the various jobs of mining coal, determination of standard or normal time required to do the jobs, measurement of performance against these standards, and the balancing of work in groups by distribution of the work in equal amounts to each of the production men in a crew.

The company does not have a formal maintenance program at this date, but has extended its industrial engineering program to accomplish some functions of what management feels would be included under such a program.

To illustrate this point, a given year without any systematic maintenance program resulted in an average 12.7 percent for mechanical delays. The following year a maintenance program that utilized some of the principles involved in the company's industrial engineering program was installed and resulted in an average of 7.6 percent for mechanical delays or a net decrease in this type of delays by 5.1 percent.

Systematic Procedure for Maintaining Equipment

The maintenance control program now in effect affords a systematic procedure for maintaining the equipment through three phases as follows: (1) trouble shooting (2) preventive maintenance, and (3) major overhaul.

Trouble shooting is performed during the production shift and consists of making minor repairs to equipment that has been temporarily "knocked out" of production due to electrical and/or mechanical failure. These types of failures are corrected by mechanics working on the production shift where delays are reported.

The dispatcher on duty informs the mechanic by phone or radio as to the nature of the trouble and the section on which it occurred. The mechanic or mechanics go to the section by mine jeep and make the necessary adjustments or repairs as quickly as possible so that the machine can be put back into production.

Trouble shooting accounts for 36 percent of the manshifts of the total maintenance force.

Preventive maintenance is performed during the idle shift of each section. There are two mechanics assigned to each section to inspect and make necessary adjustments and repairs to the equipment that may prevent costly failures to it during the production shift.

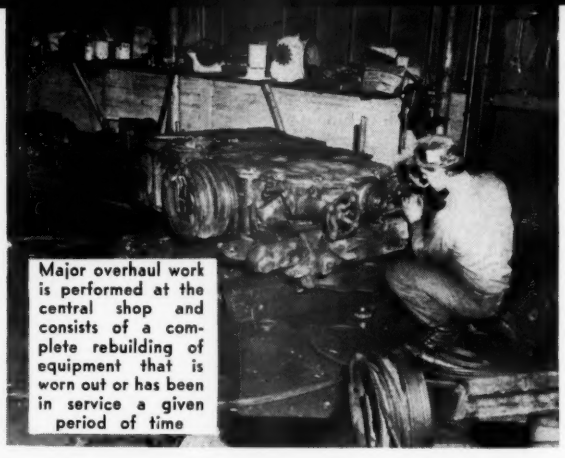
There are reports to be made out daily by the mechanics covering each piece of equipment that is under their care and supervision. This list of equipment would include the loading machine, cutting machine, shuttle cars, hydraulic drill, stoper, stoper trucks, loading elevator, car hoist, power cables, etc. These forms cover all important inspection points on each piece of equipment and must be made out during the inspection period. Recommendations are made for replacement parts needed on any piece of equipment. The completed form is given to the chief electrician who studies it and takes any further action that might be needed and then files it for future reference.

Preventive maintenance is considered to be the most important of the three phases of the program since the best way to prevent "down time" on production equipment is to correct possible causes of trouble before they develop into failures.

This part of the maintenance control program requires 39 percent of the manshifts of the total mechanical maintenance force.

Major overhaul work is performed at the central shop and consists of a complete rebuilding of equipment that is worn out or has served a given period of production time. The equipment is moved from the mine to the shop upon the recommendation of the

The primary purpose of preventive maintenance is to detect small defects or malfunctions of machinery, and to see that they are corrected before they develop into major breakdowns



Major overhaul work is performed at the central shop and consists of a complete rebuilding of equipment that is worn out or has been in service a given period of time

chief electrician. It is taken apart and inspected, and a report is made out and given to the purchasing department showing the necessary parts required for the overhaul work. The piece of equipment is then placed on the shop schedule of overhaul work upon receipt of the supply parts that have been requisitioned and is returned to the mine immediately following completion of the rebuilding job.

This phase of the maintenance program requires 25 percent of the manshifts of the total mechanical maintenance force.

The value of a sound maintenance program can readily be seen when delay time is converted into lost dollars or revenue. Let's illustrate this by citing a concrete example. Lorado operates a mine that has a capacity of one ton or more of clean coal per minute of unit operation. Since the greatest portion of mine cost continues throughout the delay time, each lost minute for this mine would have an economic loss equal to one ton of coal at the average realization received for the past several months. This mine with the above stated capacity has approximately 420 available minutes for production, and on a ten-unit shift basis applied to the average realization for the past year would show each operational minute to have a value of $53.00. A mechanical delay of one percent is equal to a loss of $222.60 in this particular situation.

The reduction in mechanical delays by 5.1 percent cited earlier with a value of $222.60 for each one percent would result in a savings or additional income of $1135.00 per day that was effected by a planned, systematic maintenance program. The elimination of all mechanical delays may not be a possibility, but any reduction is certainly worthwhile and merits the whole-hearted support of management as well as the mine maintenance force.

What Must an Effective Program Stress?

Lorado believes that an effective maintenance program must stress the following: (1) rigid inspection, (2) preventive maintenance, and (3) periodic or scheduled overhaul.

Rigid Inspection. A routine check list type of inspection by the mechanic force is not sufficient to determine the condition of mining equipment. The duty of making inspections should be delegated with corresponding authority to a person whose other responsibilities include the reduction or minimizing of delays and the selection or scheduling of equipment for overhaul. Inspections made by this person will also serve as a check on the effectiveness of the preventive maintenance work part of the program.

Preventive Maintenance. The primary objective or purpose of preventive maintenance is to detect small defects or malfunctions of machinery, and to see that they are corrected before they develop into major breakdowns. This gain or benefit cannot be realized if management expects the preventive maintenance personnel to perform extensive repairs to the equipment. If adequate labor to perform preventive maintenance only is allowed in the manpower budget, the additional duties of extensive repair, if it is assigned to them, will result in neglect to the primary duty of preventive maintenance and may be the cause of incompetent work on extensive repairs to the equipment. It is felt, therefore, that additional labor should be provided, and held responsible for the extensive repairs or the equipment should be marked for the overhaul phase of the program.

Periodic Overhaul. The maximum period of time between overhauls for any piece of equipment can be determined most accurately by inspection. If mining conditions throughout a mine were uniform, overhaul schedules for the equipment could be established on a tons mined or a stated time interval basis. This phase of the program cannot be so rigidly set because in most mines the equipment is subjected to varying conditions. Therefore, a tons mined or time interval basis does not provide a valid basis for scheduling the equipment for overhaul that is in the worst operating condition.

It is felt by many that a scheduled overhaul program is prohibitive as to cost and is a wasteful means of equipment maintenance. An example from Lorado's own experience will show that this method is economically sound. A formal or scheduled overhaul program for all of the company's mining equipment was put into effect for a one year period. The parts and jobbers cost for one mine during this particular year amounted to $456,099.00 under the above program. The following year this same mine with its equipment was allowed to deviate from this systematic programming of maintenance and with little or no overhaul work being performed the parts cost alone amounted to $475,442.00.

The latter year certainly reflects an increase in supply costs but it is evident that without the overhaul program approximately the same amount of money was expended. The obvious conclusion to be drawn from this example is that without the overhaul programming and expenditure of as much money as under the planned maintenance work, mechanical delays would increase and a corresponding decrease in tonnage would follow.

Maintenance Vital in Continuous Mining

A sound maintenance program is of paramount importance when considering continuous mining machines. The conventional method of mining involves separate cycles of operation. Mechanical failure with conventional mining can be relieved somewhat by increasing the capacity of the machine most likely to break down or the failure of which would result in the greatest loss of production. This method provides for an unbalanced work cycle to protect against mechanical failure or delays. Continuous mining is inherently a balanced work process, therefore, optimum production can be obtained only by keeping these machines operational at all times. These machines cannot be kept operating 100 percent of the working time, but a sound maintenance program provides the sole means of approaching full availability.

The Federal Aid Highway Program started in 1916 with an appropriation of $5,000,000 for the fiscal year 1917. The tremendous growth in the program is indicated by the apportionment for 1960 of $3.4 billion. Even with government participation on this scale, however, it may be said that the road user is footing the bill for the entire Federal share

IMPACT OF THE FEDERAL ROAD PROGRAM ON THE MINERAL INDUSTRIES

The mineral industries not only have a great opportunity, but also a real responsibility in meeting the challenge posed by the new expanded highway program

By C. D. CURTISS

Special Assistant to the
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AT the outset it should be noted that few, if any, of the materials that will be required in great quantities in the new program have any great intrinsic value as they occur in nature. It is only after they have been mined, transported and processed into finished or partially fabricated products that they have value for highway purposes. Here the mining and related industries play a most important — yes, an essential part in the highway program.

Whether you realize it or not, you—the mining and related industry—not only have a great opportunity, but also a real responsibility in meeting the challenge posed by this new expanded highway program.

Government Entered Nationwide Road Building in 1916

Before getting into the details of your place in the highway picture, it might be well first to discuss the Federal part in the current program and review the events leading up to it.

Although the forerunner of the United States Bureau of Public Roads was established by the Congress in 1893, it was not until 1916 that the Federal Government entered the road building field on a nationwide basis. The Federal Aid Road Act of 1916

and the Federal Highway Act of 1921 established certain principles which still govern the Federal aid highway program. These are as follows:

(1) Cooperation with State highway departments
(2) Federal-aid funds to be expended in the improvement of selected systems
(3) Initiative in the selection of systems, route locations and projects for improvement rests with the States
(4) State highway departments make the surveys, prepare the plans, let the contracts and supervise construction, subject to approval of the Bureau of Public Roads
(5) States maintain at State expense highways constructed with Federal aid
(6) State funds are required to match Federal funds. Normal matching is 50-50, with a sliding scale in the West where there are large areas of public lands. (On the Interstate System, the Federal Government will pay 90 percent of the cost.)
(7) Federal-aid funds are apportioned among the States under formulas stated in the law involving the factors of area, population, and mileage of rural delivery and star mail routes. (The 1956 law provides that starting in 1960, Interstate funds will be apportioned on the basis of need. This method will permit all States to progress the work at a uniform rate.)

The 1921 Act provided for the selection of a Federal Aid Highway System not exceeding seven percent of the highway mileage in any State. Federal aid was restricted to this system which is known now as the primary system.

The program started with $5,000,000 of Federal funds for the fiscal year 1917. The tremendous growth in the program is indicated by the apportionment for 1960 of $3.4 billion, which became available on August 1, 1958. This is nearly as much as was provided in the first twenty-five years of the program. Of this total $2.5 billion is for the Interstate System and $900 million for the primary, secondary and urban Federal-aid program.

In 1916 there were 3,600,000 registered motor vehicles; in 1957, 67,200,000. It has been estimated that there will be 80,000,000 motor vehicles in 1965 and 100,000,000 or more by 1975. Traffic has reached astronomical figures—

1957	**642 billion vehicle miles**
1965—(est.)	**800+ billion vehicle miles**
1975—(est.)	**1000+ billion vehicle miles (trillion)**

Progressive Outlook Developed

Between the two World Wars a vest network of Federal-aid highways was built. Most of these were two-lane roads planned to catch up with already existing traffic demands. But few were built with the long range future in mind.

As traffic increased, many sections

Industrial mineral producers have a big job ahead. For example, it is estimated that each $1,000,000 of construction contracts will require about 79,000 tons of aggregates and 17,000 bbl of cement

of this primary system became quite inadequate — especially the main routes serving large cities and industrial areas. Motor vehicles multiplied and their use overloaded the roads.

Even during World War II with traffic restricted, highway problems were multiplied. The mistaken war time policy of considering our highways expendable worsened the situation. But during this period, the whole highway problem was brought into sharper focus, and we began to see the picture more clearly and as a related whole.

After extended consideration by the Congress, the Federal Aid Highway Act of 1944 was passed. It took three important steps. It provided for the selection of a Federal-aid secondary system—the farm-to-market roads. It provided for the first time specific funds for improving extensions of the primary and secondary systems into and through urban areas, and it called upon the States and the Bureau of Public Roads to designate a National System of Interstate Highways, limited in extent to 40,000 miles and connecting the important cities and industrial centers of the country (increased to 41,000 miles by the 1956 Act). Special consideration of the National Defense was required in the selection of the system.

By 1947 the States and the Bureau, in consultation with the military, had selected the intercity routes and the job of selecting and designating the urban additions making up the full 40,000 miles was completed in 1955.

We had come a long way in our thinking, in our concept of the highway problem and there was general agreement among highway officials on the remedies required. The needed improvements could not be made, however, because sufficient funds were not available and in the late 1940's there was no prospect of getting sufficient funds to complete the Interstate System in any reasonable period of time. In the meantime, traffic pressures, accidents, congestion and delay continued to mount.

In 1954 Congress called for an inventory of highway needs and in June of that year President Eisenhower's urgent message to the Governors' Conference proclaimed the critical need for a greatly enlarged and accelerated highway program.

Interstate System Vital to Nation's Defense

The Federal Aid Highway Act of 1956 embraced the philosophy of the "Grand Plan" called for by the President. It also reflected the long and patient efforts of the 84th Congress, State highway officials, and a number of organizations, including the American Road Builders' Association, which gave firm support to the new program. Because of the great importance of the Interstate System to the national defense, Congress added the word "defense" to the full name of the Interstate System, and increased the Federal share of the cost to 90 percent. A total of $25 billion was authorized to become available over a 13-year period which, at the time, was considered adequate to complete the system. A new estimate submitted to the Congress in January 1958 indicated the need for a considerable increase in funds. This need has been met in part in the Federal Aid Highway Act of 1958 which increased the Interstate authorizations for 1959, 1960 and 1961 by a total of $800,000,000.

The 1956 Act required that the Interstate System be built to standards adequate for the traffic of 1975. It will consist mostly of multi-lane, divided highways with limited or planned access. Planned access means that traffic enters and leaves the main highway on specially designed ramps or interchanges which facilitates the movement without interference with the through traffic. It is the only method by which the traffic capacity built into the highway can be maintained during its useful life. *Even without this economic justification, the added safety of planned access fully warrants its inclusion in the standards since accidents are reduced by two-thirds.* The standards proposed by the American Association of State Highway Officials and approved by the Bureau of Public Roads are not high considering the services the Interestate System will render. The control of access is the keystone of the standards arch and must prevail if the Interstate System is to handle safely the traffic of 1975.

While consisting of only about 1¼ percent of the nation's highway mileage, it is estimated that the system will carry 20 percent of all vehicle miles of traffic when completed.

While much publicity has attended the initiation of the Interstate Program because of its urgency and the fact that it is the greatest public works program ever undertaken anywhere at any time, the regular primary, secondary and urban, or ABC Federal aid program as it is often called, was not overlooked by the Congress when the new program was authorized. These ABC funds with 50-50 State matching funds are available for improvement of two principal systems and their extensions into urban areas—the 250,000-mile Federal-aid primary system, which includes the Interstate network, and the 528,000-mile Federal-aid secondary system.

The ABC program is a continuing one with funds authorized by the Congress every two years. Funds for this program averaged $500,000,000 for the first nine post war years. The 1956 Act increased these funds to $850,000,000 for the fiscal year 1958 and $875,000,000 for 1959. The 1958 Act increased the ABC funds for 1960 to $900,000,000 and for 1961 to $925,000,000. These funds are divided as follows:

45 percent for projects on the primary system,
30 percent for projects on the secondary system, and
25 percent for projects on extensions of these two systems into and through urban areas.

Federal funds are also provided for road work on the Federal Domain—National Forests, National Parks and Parkways, Indian Reservations and other Public Lands. The 1958 Act provided $112,000,000 for this work for each of the fiscal years 1960 and 1961.

The Road User Pays Entire Federal Share of Program

The 1956 Act was noteworthy in another respect. It set up a Trust Fund in the United States Treasury into which revenues from certain Federal Road User Taxes are placed and from which appropriations are made to finance the highway program. Previously, all Federal Road User Taxes had been placed in the General Fund of the Treasury and appropriations were made from the General Fund to support the Federal-aid highway program. There was no legislative linkage between the motor fuel and motor vehicle taxes and road appropriations. Now it may be said that the road user through these special Federal taxes is footing the bill for the entire Federal share of the road program.

All of the systems mentioned above are connected and interdependent.

Highway construction is expected to exceed $7.0 billion by 1960, at which time the total steel consumption should be well above the 3,000,000 ton mark

The highway and mining industries use many similar items of equipment. Improvements and new equipment developed through the work of one industry almost invariably help the other

Traffic can switch back and forth from one to the other and does so endlessly. Each enhances and serves the other.

Impact on Mineral Industries Will Be Considerable

Now what will be the impact of this huge program on the mineral industries?

It will be considerable, both direct and indirect. Following is an estimate of the average amount of some of the major materials that will be required in the new Interstate program for each $1,000,000 of construction contracts:

Steel: Structural	**336 tons**
Reinforcing	**245 tons**
Culvert pipe	**17 tons**
Miscellaneous	**48 tons**
Aggregates	**79,000 tons**
Cement	**17,000 bbl**
Concrete pipe	**522 tons**
Clay pipe	**21 tons**
Motor fuel and lubricants	**133,000 gal**
Bitumens	**916 tons**
Explosives	**31,000 lb**
Lumber	**100,000 fbm**
Timber Piling	**16,000 fbm**

The mining industry will be interested directly in some of these materials that are required for use in the road program and indirectly in the same materials that are required by the industries processing and transporting the highway materials.

It has been estimated that the volume of steel used on highway construction reached the 2,000,000-ton mark in 1956 when the capital expenditure for highways was about $5.0 billion. Construction is expected to exceed a $7.0 billion level by 1960, at which time the total steel consumption should be well above the 3,000,000-ton mark. About two-thirds of a gallon of paint is required for each ton of structural steel. The increase in steel is not only due to greater expenditures for highway construction but also to the fact that the steel requirements for the Interstate System have raised the average consumption factor per million dollars of expenditure. Latest estimates show that nearly one structure per mile will be required on the 41,000-mile Interstate System. Previous estimates show that other Federal-aid systems will need about one structure every five miles to bring them to a desirable standard of improvement. Construction equipment requirements also generate a demand for considerable quantities of steel and other primary metals.

On-site cement consumption (excluding quantities used in concrete culvert pipe and other precast products) should approach the 100,000,000 bbl mark by 1960. This is about 50 percent more than was consumed in 1956.

A considerable amount of aluminum products is already being used in highway construction, principally in the form of bridge rails and traffic signs. New developments such as aluminum guard rails and a revolu-

The Interstate highway program is on schedule and moving rapidly to a plateau of construction that must be continued for 10 years if the vitally needed transportation arteries are to be completed on time. Some obstacles stand in the way which must be overcome by an informed and interested citizenry

tionary design of bridge beams similar to that of an aeroplane wing give promise of a greater use of this material in future highway construction.

The production of aggregates for bridges and highway surfaces has been greatly accelerated since the inception of the expanded highway construction program. Surveys show that anticipated shortages of sand and gravel in a number of states will require additional quarrying operations to meet the highway demands.

Fiberglass, a product of silica sand, is relatively new in the highway field, but it shows promise for the fabrication of a number of items. It has been used successfully for highway signs and supporting structures, and a guard rail section is now under test.

In some areas the expanded highway construction program might afford an opportunity to dispose of some of the better quality mine waste or stripped overburden by using such material for selected subgrade and borrow.

Although the present supply of asphalt and paving oils obtained from petroleum wells appears adequate at this time, it is reassuring to know that if serious shortages should develop it would be possible to produce bituminous paving materials by mining and processing the oil-bearing shales.

Several Improvements of Mutual Benefit

The highway and mining industries use many similar items of equipment and the improvement and new equipment developments through the programs of one industry almost invariably help the other. Substantial improvements to power shovels and to conveying and loading equipment engaged in highway activities have also benefitted mining. Extra heavy-duty motor graders in the 150 and 190 hp ranges are ideal for stripping overburdens in open pit mining and in maintaining haul roads. Development of the electric wheels for heavy duty hauling could be a boon to the mining industry in reducing the need for high standard haul roads. Perhaps one of the most outstanding developments in highway equipment is the successful application of electronic control to a motor grader blade. With this new innovation, the blade can be automatically kept level or to a desired slope without regard to the irregularities encountered by the grader wheels. This same principle of automatic control can be utilized in controlling the movement of dozer blades, trenchers, finishers, or other equipment units which are required to work to finished grades and cross sections. There are probably several areas in mining methods where this principle could be utilized to advantage.

The Federal-aid Highway Acts of 1956 and 1958 provide for the acceleration of construction of Forest Highways in the National Forests as well as roads on other Federal domain. Most of these increased authorizations are allocated to the 11 Western States which coincide with the principal mineral producing areas. It is reported that from geologic indications, a large portion of the minerals yet to be developed in this country are located in lands in the Western States belonging to the Federal Government. These 11 States produce nearly all of the copper and over one-half of the lead and zinc mined in the United States. The mining industry, therefore, benefits in both a general and a special way under the current highway construction program.

When it is realized that about one out of every seven gainfully employed persons in the United States is engaged in some phase of work connected with the industries supporting highway transport, and that its maintenance and growth is dependent on an adequate highway system, the importance of the new highway program takes on added significance.

For many years, broken only by war-time restrictions on travel, the curve of traffic growth has shown a marked similarity to the curve depicting gross national product. Such a continuing relationship through the years would seem to indicate rather conclusively that there is a definite interdependence between highway transportation and economic progress. It seems clear, therefore, that we can no longer let highway transportation be hampered by inadequate highways. While highway transportation is competitive in some degree with other forms of transportation, it also is an essential supplement to practically every other form of transportation.

Thus, the new highway program will exert an influence on the economic progress of the nation from which your industry will benefit both directly and indirectly.

During the war, the Federal Government financed with special funds the building of access roads to the natural sources of supply of strategic materials. These access roads led in from the main roads usually a route of one of the Federal-aid systems. In many instances the regular Federal-aid and State matching funds financed all or part of the needed access. This

service is continuing under the current program the expansion of which makes for cheaper transportation from mine to processor.

To Complete System on Time Everyone Must Help

In the 1956 Act, Congress declared, "It . . . to be essential to the national interest to provide for the early completion of the 'National System of Interstate and *Defense* Highways'," and further that, "it is the intent of the Congress that the Interstate System be completed as nearly as practicable over a thirteen-year period and that the entire System in all the States be brought to simultaneous completion."

Now that Congress has expressed in unequivocal language the importance of the Interstate System, and the intention that it be completed in 13 years, it might seem that those interested in highway transport could sit back and without further effort enjoy the benefits of this unprecedented program. However, such is not the case. Here are some of the reasons why:

1. While the quoted provisions are entirely clear as to intent, another provision in Title II of the 1956 Act, setting up the Trust Fund, carried a pay as you go provision (Byrd Amendment), which prohibited incurring a deficit in the Trust Fund. With the increased cost estimate the Trust Fund receipts will be inadequate to finance the program in 13 years. It might take 20 or more years. We can not offord to wait that long. Further Congressional action is necessary to put the Interstate program back on a financial support schedule that will ensure completion as contemplated in the 1956 Act. Less than 60 per cent of the present Federal road user taxes have been going into the Trust Fund.

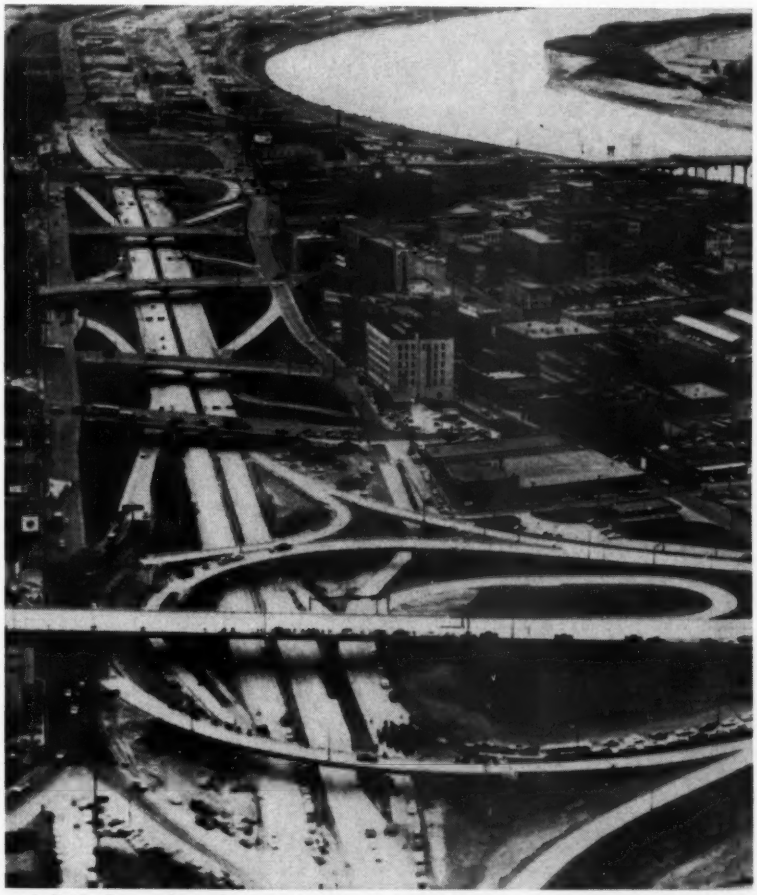
2. The 1956 Act called for a series of estimates of the cost of completion of the Interstate System. These estimates were to be used to form the basis of apportionments of the authorized funds among the States. This plan permits division of the Interstate funds among the States on a needs basis, using the so-called "needs formula." Its use is necessary if the States are to advance their Interstate programs uniformly. The first estimate, made cooperatively by the State highway departments and the Bureau of Public Roads, was submitted to the Congress in January 1958, but was approved for use in the 1960 apportionment only. Until legislation (H.R. 12808) introduced by Congressman Fallon, Chairman of the Roads Subcommittee in the House, is passed, there will be no legal means of apportioning the 1961 and 1962 funds.

3. Public hearings are required on the location of projects before plans can be submitted by the State Highway departments to the Bureau of Public Roads for approval. This is a good public relations outlet for the State highway departments, but it also gives those opposed to a location for selfish personal reasons an opportunity to object and sometimes delay action. Support of the State highway departments at these hearings is necessary from those who believe the locations proposed are appropriate. Purely selfish opposition, even though quite understandable, needs to be countered. In the words of "Mr. Harper" in the American Road Builders' Association's film, "We'll Take the High Road," there are times when the individual must give up something for the benefit of the community as a whole. This is especially true in the Interstate program. The highways must go somewhere.

Individually you have an opportunity as leading citizens in your home communities to render real aid to the program by helping your State highway department get the right location for the Interstate highways. At public hearings you can give support to the necessary standards when they are questioned—largely because of a lack of understanding of their great importance. Through membership in local organizations further help can be given by serving on legislative committees that lend support to needed State and National highway legislation. In some States inadequate and obsolete laws need modernizing. This is particularly true in the field of right of way acquisition.

In closing, the author is glad to report that the Interstate highway program is on schedule and moving rapidly to a plateau of construction that must be continued for 10 years if the vitally needed transportation arteries are to be completed on time. We need these highways for our future economic growth and must have them for national defense and the driving safety of our people.

Let's all work together to firm up the Trust Fund and keep the Interstate highway program on a sound and firm financial footing.



Individually you have the opportunity as leading citizens in your home communities to render real aid to the highway program by helping your State highway department get the right location for the Interstate highways

An OPERATIONS RESEARCH APPROACH to Mine Haulage

Operations research—a means of solving problems with a large number of variables—has been used with great success to answer many difficult questions of production and programming. Two men tell how this approach can be used to design mine haulage systems, citing many interesting examples

By ERNEST KOENIGSBERG
Manager, Management Sciences
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PERFORMANCE of the bituminous coal industry has been among the very best American industrial achievements during the past ten years. The constant battle against rising production costs has been fought resourcefully and has almost always been won. Nevertheless, the competition presented by other fuels and all the other pressures on production and profits continue to exist, so that the industry must even accelerate all efforts to maintain low production costs or to reduce them.

The development and application of continuous mining machines show promise of high production at low cost. It brings in its wake, however, extreme demands on haulage and materials handling systems which were adequate previously. Installation of the new machines thus automatically calls for a critical appraisal of the haulage and materials handling systems that are to accompany them. Studies of these systems and the resulting improvements in them can also naturally lead to more efficient production from conventional mines. In fact, there is at the present time a need for a study of haulage systems in general and their effects on overall mining efficiency. One technique for carrying out these studies and obtaining such improvement is operations research.

The phrase "operations research" is very O.K. these days, but it has earned its reputation. It can be defined as the use of scientific and mathematical methods in the solution of business problems (which in themselves are not scientific in the usual sense). The scientific approach is well established and has proved to be the most fruitful method of problem solving. The application of the scientific method to business and military problems is of more recent vintage; in fact, it can be said to have originated in Britain during the last war. In spite of its comparative youth, there are already many instances of its success in a wide variety of industries; mail order selling, railroad operations, warehousing and distribution, manufacturing of both hard and soft goods, petroleum and phosphate mining, to list just a few. The most interesting examples from our point of view, however, will be some drawn from the mining industry itself and the coal industry in particular.

Face Operations

The first example is related to face operations in a conventional mine. This is selected because: (a) it illustrates some basic concepts of operations research and (b) it was done in the U. S. A.[1] The study was undertaken to see if an analysis would allow the output from a conventional section working under prescribed conditions to be determined without costly experiments and to examine how the output might change as working conditions, operations or equipment were changed.

In physical terms conventional coal mining operations consist of a number of machines M (cutter, loader, etc.) which queue up in fixed order to service N faces, also in fixed order. The faces present themselves to the machines in a cycle as shown in figure 1, because a machine which has completed service on the last face returns to face I and repeats the cycle of operations. The time to perform each operation is not a constant, but varies in a more or less random manner, represented in the subsequent calculations by the exponential distribution.

In setting up the mathematics, the problem was considered in terms which are actually the reverse of the physical ones; the M machines were regarded as fixed with a closed loop of N customers (or faces) lining up for service at each machine on a "first-come-first served" basis. Figure 2 shows how the "model" describes the state of affairs shown in figure 1. The time needed by a particular machine to "service" each face is a random variable (and includes breakdowns and transit times).

This mathematical "model" or representation leads to rather straightforward expressions for many essential operating parameters including:

a. The output of the system (or section), Θ

b. The mean cycle time to complete service at all M stages (T)

c. The utilization factor of each equipment unit (U_1, U_2, . . . U_M) and of the whole production unit, U.

Some typical results based on actual operating data are illustrated in Table I. The agreement between the theoretical result (49.0 tph) and the actual output (48.5 tph) is close enough to show the success of the model. The model can be used to determine the effects of changing the "service" times of any machine, of doubling up on slow machines, of changes in operating conditions which affect cycle times, etc.

(Continued on page 66)

Author of many technical articles, Ernest Koenigsberg has served as group leader, Special Studies Group, EMI Engineering Development Ltd., Hayes, Middlesex, England; senior project analyst, Midwest Research Institute, and associate physicist, Ames Laboratory, AEC. Prior to his present position with Touce, Niven, Bailey and Smart, he was head of the Operations Research Section, Midwest Research Institute. He supervised and directed activities of the Operations Research staff and worked with other groups in statistical analysis and design of experiments.

Discussion:

AN OPERATOR'S VIEWS ON O. R.

By OSCAR D. McDANIEL, JR.
Manager, Industrial Engineering
Old Ben Coal Corp.

O. D. McDaniel was employed by Old Ben Coal Corp. in 1946, serving successively as junior field engineer and washery plant foreman. In 1954 he joined the company's newly formed production engineering section, and in 1956 was made chief production engineer, engaged in organizing and training newly formed Industrial Engineering Department. Appointed manager of Industrial Engineering in 1958, he is also a member of Operations Research, subcommittee of Mining Advisory Group, Bituminous Coal Research, Inc.

THE article by Dr. Koenigsberg has demonstrated in a very capable manner the application of operations research techniques to one of the industry's major mining problems. Can a mining company use these techniques? Are its problems sufficiently complex to warrant the application of operation research techniques? These are not questions that a company can adequately and accurately answer unless it has surveyed its operations. Operational problem-decisions are finally based on the economic situation which results in some benefits. Similarly so, the expensive problem-solving techniques being discussed must have financial benefits to become an effectual tool of mining management.

Consideration of Variables

As Dr. Koenigsberg has indicated, the application of mathematical models to problem-solving by computer is not required in many instances. It is only when the conditions surrounding the problem cast shadows, known as variables, upon certain factors of the problem.

When considering haulage problems, industry's past research was limited to determining the size locomotives to be used, the number and size of mine cars required, the proper size and length of belt conveyor to use, and always the more complex problem of comparing operating costs for belt and mine car haulage. Theoretical methods of solving these problems have served the industry for many years and usually simple mathematics was sufficient to provide an answer.

Companies realize the variable factors which exist in their haulage system. One is car distribution, being affected by variable sectional production, variable capacity of dumping facilities, variable lengths of haulage, inconsistent downtime and other factors. The consideration of such variations, certainly beyond the scope of simple mathematics, usually was limited to the use of an average or mean condition and on some occasions even devalued by exclusion as a factor. It was not important whether such factors were included or excluded if the actual results approximated the expected. More often than not, the results were short of the predicted goal. It can be assumed that the majority of misinformed decisions have been based on limited research which failed to recognize the existence or interrelationship of the variable factors.

Hunt and Peck System

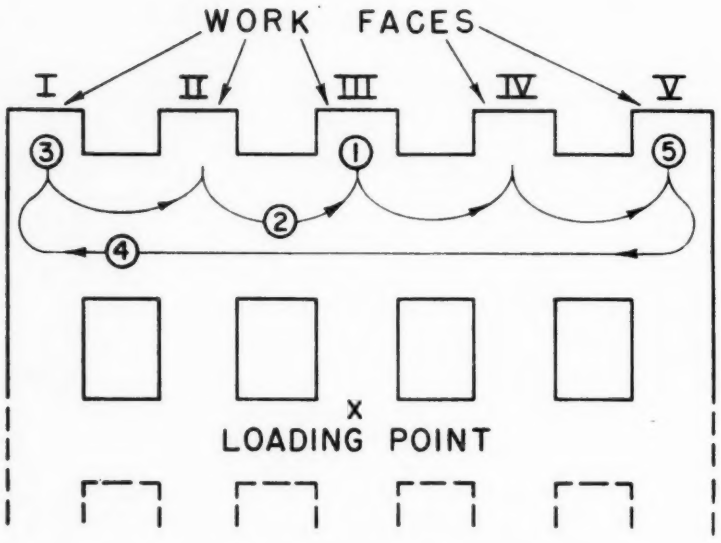
Often management, to avoid expensive errors, pursues the timid but tedious path of one change at a time. Let us examine an actual example of this in the area of mine haulage.

Mining from room and pillar system, a production crew equipped with 11BU loader, 10RU cutting machine, CD26 coal drill, RBD11 roof bolter, and two 10SC shuttle cars was being serviced by one motor on a single track.

1. **The first corrective measure taken was to add another track. This shortened the trip interchange time, since the car storage could be kept closer to the loading point.**
2. **A time later a second motor was added to further decrease the delays to production. At this point, no further delays resulted from the track haulage system, but the mine's haulage problems were not completely solved. There had been an increase in tonnage, but management found that the intermediate haulage, the shuttle cars, had become the limiting feature to increased production.**
3. **A third shuttle car was added. This was thought to be the obvious answer. Equipment was available but the results were not as outstanding as had been produced by previous changes. Too often mining conditions were encountered which limited either travelways or hampered face equipment output; hence, the cost of the extra man and machine was not warranted.**
4. **Some change in mining plan was necessary to decrease the production limits imposed. The restrictive character of mining plans was difficult to analyze. But faced with the problem of securing better utilization from haulage facilities, it was impractical to ignore the interrelationship of shuttle car haulage and other sectional production equipment, particularly the loading machine. To secure information as to the nature of these binding factors, a trial section was set up. Ordinarily the mine produces from room mining by advancing seven faces, then retreating by pillar-robbing. In this case, the mine advanced 14 faces or rooms concurrently. Previously determined cycle time for mining equipment indicated a need for a second drilling machine and loading machine. The three shuttle car haulage was found to be satisfactory. In this situation an average of 888 tons per shift was maintained and the unit reached the maximum of 960 tons per shift. During the trial period, the second piece of drilling equipment was dropped without affecting the production. Unit cost was substantially reduced although the experimental nature of the trial slightly increased cost, but the real failure to reach even higher tonnages came from the heavy absorption of production time in tramming machines, changing trailing cables nips, changing dumping points, etc. Chart I compares the predicted with the actual as taken from the Industrial Engineering Section records.**

In this case, the operation included sufficient interrelationships so that the optimum productive solution was not developed. Actual results provided the answer.

(Continued on page 69)



① INDICATES MACHINE LOCATION AT AN ARBITRARY INSTANT OF TIME

Fig. 1. A typical mine layout. The machine groups (Arabic numerals) work the faces (Roman numerals) in cyclic order

ERNEST KOENIGSBERG

(Continued from page 64)

Rail Haulage

Another example is concerned with rail haulage. The work was carried out by the National Coal Board (U.K.) whose "Field Investigation Group" (F.I.G.) is the largest non-military operations research section in England and is probably larger than that of any individual business group in this country.

British mines are operated under conditions very much different from those in the United States and they have by no means reached the same degree of mechanization as our bituminous industry. Geological conditions require the employment of the "long wall" system of mining which is not as amenable to mechanization as the "room and pillar" system. The National Coal Board is, however, engaged in a long-range modernization program aimed at raising productivity levels to figures nearer to those over here. As part of this long-range program, F.I.G. has made a series of fairly comprehensive studies of underground haulage costs comparing various rail systems with conventional and other conveyor systems.

One series of studies which has been extensively reported by Cook [3, 8], Evans [3, 4] and Clapham [5, 6] involves the analysis of cost of operation (per ton and per ton mile) for battery, diesel and trolley locomotive systems as a function of maximum grade, distance from face to shaft and size of mine. The study was begun in 1948 when the industry was changing from rope to locomotive haulage and an assessment of the relative costs of haulage was desired. Cost figures were obtained for all of the mines which had locomotives (in 1948 there were 15 mines with battery locomotives and 15 with diesel locomotives), but no conclusive results could be obtained. Part of the difficulty lay in the fact that, although a battery locomotive was hauling the same ton mileage per locomotive shift, it was operating closer to its maximum capacity than the diesel. To allow for this factor a formula (based on traction theory) was developed, from which the hauling capacity of each type of locomotive could be calculated for particular conditions.

The next step was to divide the various costs at each mine into four groups according to the main factors which influence cost. These were:

Group I—The cost of having locomotives capable of hauling so many ton miles per shift.

Group II—The cost of having an extensive track system on which the locomotive can run.

Group III—The cost of manning the locomotive haulage system.

Group IV—The cost of using the system to haul coal.

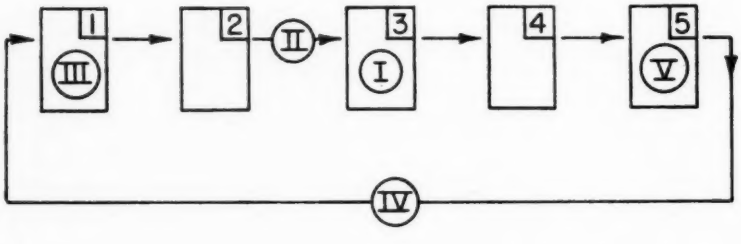
This cost breakdown allowed the development of fairly simple equations which expressed the cost as a function of the number of locomotives, the total tonnage of the locomotives, the number of useful ton miles per week, the number of locomotive shifts per day, the number of 100 kwh capacity installed, and the number of 1000 yd of track installed. The equations proved fairly reliable and the analysis has since been extended to rope and conveyor haulage systems.

The conclusion was to recommend diesel locomotives for large-scale haulage or for continuous heavy haulage. The study was extended to include trolley locomotives which proved to be cheaper than diesels for long hauls (over 1½ miles) and heavy loads. A sample result is shown in table II.

TABLE I

CALCULATED RESULTS BASED ON DATA FROM DEERFIELD MINE

Job	Time per Face (min.)	Service Rate (faces/hr)	% Working Time or % Utilization N-5	N-6	N-7
Loading	25.24	2.3772	67.0	71.3	74.3
Cutting	24.50	2.4490	65.0	69.1	72.5
Bolting	23.83	2.5178	63.1	67.2	70.2
Shooting	20.29	2.9571	53.8	57.2	59.9
		Output (tph)	45.8	49.0	50.6
		Actual Output (tph)	—	48.5	—



(II) INDICATES POSITION OF FACES AT SAME INSTANT OF TIME

Fig. 2. The conceptual model of mining operations. The machine groups are considered fixed and the faces move through the "production line" in cyclic order. The system is in the same state as shown in figure 1.

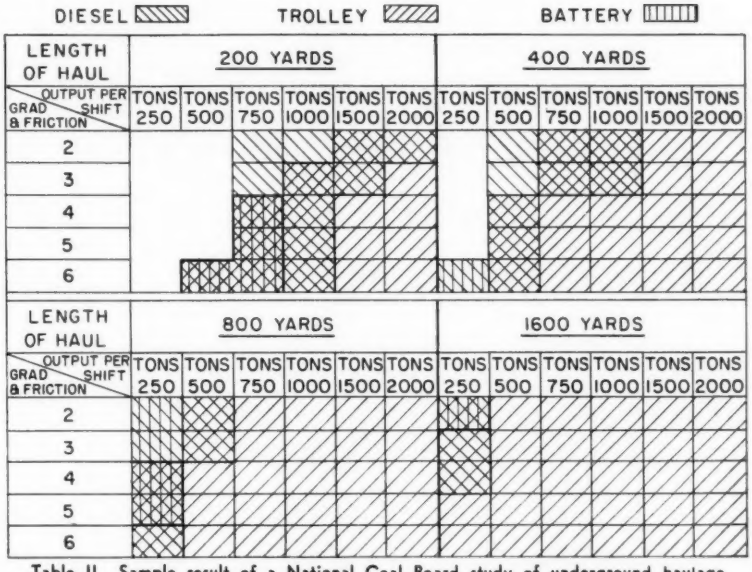


Table II Sample result of a National Coal Board study of underground haulage cost. Study involved the analysis of cost of operation (per ton and per ton mile) for battery, diesel and trolley locomotive systems as a function of maximum grade, distance from face to shaft and size of mine. Trolley locomotives proved the cheapest for long hauls (over 1½ miles) and heavy loads

Models

Practically all of the operations research work in the mining industry has combined the techniques of industrial engineering, work study and cost analysis. Relatively little effort has gone into the study of systems in themselves and to the formulation of mathematical and statistical models of the operation.

Because of the random nature of the work and travel times, "average times" give no indication of interference between machines. In setting up models, however, the distributions that characterize important time periods can be taken into account. Representations, developed on this basis, have proved of great value in other industries and in the study of face operations described previously. The model provides a tool for measuring the effectiveness of the system and for studying the effects of changes in the system on the efficiency, output, cost, etc. In view of the contemplated changes in mining methods and the fact that in many mines the haulage systems can set stringent limitations on output, the model approach is worthy of consideration.

The model approach, of course, is not the only way to solve an operating problem. The last example on haulage illustrates an analytic method which breaks down the operation into all of its components and synthesizes a valid equation. Good engineers going by experience, intuition and old fashioned hunches can come up with the right answers (and fortunately they often have). Operations research, and the model approach in particular, allow one to evaluate the answers without costly trials and experiments. A good operating "rule" has been provided by Solomon[7].

"A reasonably bright man on the line, when teamed up with even a dull mathematician or statistician, can be very effective, provided they learn how to talk to each other."

A recent paper by Krikovic[8] illustrates an operations research type problem which was solved without the mathematical approach. The paper is concerned with the operations of a continuous mining machine of the boring type, backed by a loading machine instead of loading directly to shuttle cars. The loading machine allows the mining machine to "make" coal for longer periods, i.e., it does not have to wait for the shuttle car. Similarly, the shuttle car is not delayed by the mining machine when repositioning is necessary. The resultant increased utilization of the shuttle cars means a more uniform feeding of the intermediate conveyor (or mine cars). The use of a loading machine means added labor and capital costs which can only be justified if it increases the production of the section.

A mathematical model of the continuous mining machine-loader-buggy-conveyor system can be developed. As a first approximation, one can use the type of analysis introduced in the

TABLE III

RESULTS FOR SHUTTLE CAR HAULAGE BASED ON DATA FROM OLD BEN NO. 9

Operation	Work Time (min.)	Work Rate (loads/hr)	1 Shuttle Car (%) Utilization	1 Shuttle Car Time for 50 tons (min.)	2 Shuttle Cars (%) Utilization	2 Shuttle Cars Time for 50 tons (min.)	3 Shuttle Cars (%) Utilization	3 Shuttle Cars Time for 50 tons (min.)
7-ton Mine Cars								
Loading	4.24	14.15	53.3		83.6		95.6	
Dumping (for each car)	3.70	16.20	46.6	63.7	36.1	41.0	27.9	35.5
4-ton Mine Cars								
Loading	4.24	14.15	52.8		80.5		93.2	
Dumping	4.03	14.90	50.1	64.2	38.4	42.2	29.6	36.4
Belt								
Loading	4.24	14.15	54.5		84.1		96.5	
Dumping	3.49	17.20	45.0	62.0	34.7	40.3	26.4	35.0

Loading time (min) = travel loaded (0.37) + travel empty (0.31) + dump (3.56)

Dumping time (min) = travel loaded (1.10) + travel empty (0.93) + { dump (1.83)—9-ton mine car; dump (1.67)—7-ton mine car; dump (2.00)—4-ton mine car; dump (1.46)—belt }

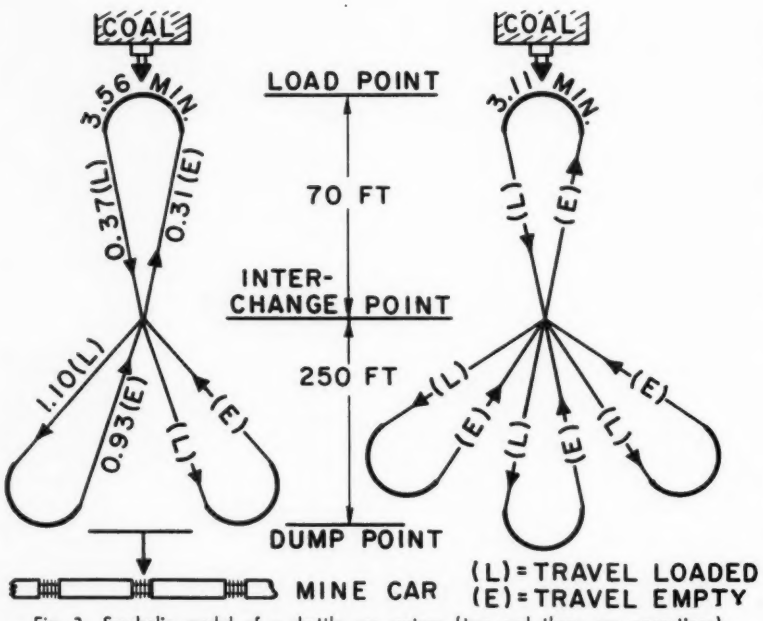


Fig. 3. Symbolic model of a shuttle car system (two and three car operations). The time in minutes for travel and loading are listed. Dump times are given in table III

study of conventional face operations.

To illustrate how this might be done the following example, based on a conventional section, is submitted. The shuttle car system is illustrated symbolically in figure 3. The system can function with one, two or three shuttle cars (only two- and three-car systems are shown) each operating in its own runway from interchange point to dump point. The mean values of loading, dumping and travel times have been determined by the Industrial Engineering Department of Old Ben Coal Co. and are listed in Table III. The model approach allows the evaluation of the work times for the loading stage as a function of the number of shuttle cars and the output of the section when one, two or three shuttle cars are used.

Shuttle car systems can be represented in model form as shown in figure 4. Stage 1 includes loading and travel time from interchange point to loader to interchange point. Stage 2 (which can have one, two or three parallel operations) includes travel time (empty and loaded) and dumping time. This model is reasonable since each shuttle car has its own runway and interference between shuttle cars only occurs in the loading stage. One can, therefore, use the mathematics already developed for face operations[1, 9]. The results are shown in Table III for seven-ton mine cars, four-ton mine cars and belt haulage. Since the loading stage is slowest, the changes in dumping time for seven-ton and four-ton cars and belts have a relatively small effect on total loader time. The effects of added shuttle cars, however, are striking; the total loader time is reduced by about 20 min. (or about 33 percent) in going from one car to two. Adding a third car reduces the total loader time by five to six min. Further additions will not reduce the total loader time by more than 1½ or 2 min. It must be remembered that adding shuttle cars may require other changes (such as shooting additional dump points in narrow seams) which add to the cost of shuttle car operations.

The net gain in productivity of the loader-shuttle car stage can only be evaluated in terms of its effect on the face operations cycle and the added cost must be compared with the value of the increased output of the section. An analysis of the output as a function of the number of shuttle cars has been carried out for a hypothetical six-face section with the following work times at each stage

Blasting	**37.5 min.**
Cutting	**30.0 min.**
Drilling	**25.0 min.**
Roof bolting	**20.0 min.**

and loading times of 60 min., 40 min. and 35 min. for 1, 2 and 3 shuttle cars, respectively. The results of the analysis are listed in Table IV. Adding the second shuttle car increases production by 10.87 tph, the third shuttle car produces only an additional 2.50 tph. It is this increase in production which must be compared with the cost of equipment and the cost of one extra man in the section.

In the January issue of Mining Congress Journal, the final part of Dr. Koenigsberg's article will discuss an operations research approach to main line haulage.

TABLE IV

CALCULATIONS OF CYCLE TIMES AND OUTPUTS FOR ONE, TWO AND THREE SHUTTLE CAR OPERATIONS: DATA FROM OLD BEN NO. 9 MODIFIED

Job	Time per Face (min.)	Service Rate (faces/hr)	% Working Time or % Utilization		
			One Car	Two Cars	Three Cars
Blasting	**37.5**	**1.6**	**56.7**	**69.7**	**73.5**
Cutting	**30.0**	**2.0**	**45.4**	**56.4**	**58.8**
Drilling	**25.0**	**2.4**	**37.8**	**47.0**	**49.0**
Bolting	**20.0**	**3.0**	**30.3**	**37.6**	**39.2**
Loading					
(1 car)	**60.0**	**1.0**	**90.9**		
(2 cars)	**40.0**	**1.5**		**75.3**	
(3 cars)	**35.0**	**1.714**			**68.6**
Output (tons/hr)			**45.46**	**56.34**	**58.84**

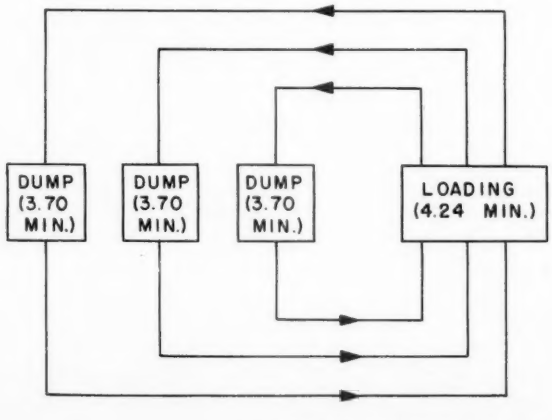


Fig. 4. Conceptual model of shuttle car system shown in figure 3 (three shuttle car operation is shown). The times include travel

O. D. McDANIEL

(Continued from page 65)

A decision based on experience and the control data was formulated in a new mining system. The mine is now employing a ten-room system in panels having 30 rooms. Previously the seven-room mining was done in four set-ups from 28-room panels. The study and development of the new system has covered the better part of two years. Many hours and days of systems analysis were involved at an undetermined cost, not to mention the price of experimental mining of the trial application. It is expensive.

Operations Research Solution

Some time later, the operations research technique was applied experimentally to this same problem by Dr. Koenigsberg and coworkers. The developed solutions, although similar in conclusion, caused considerable thought in our department. Several interesting variations existed when the two solutions were compared. This comparison is shown in Chart II.

An important similarity can be seen in the number of working places and in the outputs (tons per hour). The ability to improve the shooting work cycle at the expense of the bolting operation accounts for the slight difference in output and the ability to eliminate the need for the extra man.

Interference Between Sectional Face Operations

Returning to the subject of shuttle car haulage, the two shuttle cars provided adequate haulage capacity for this operation whereas management had determined a need for three shuttle cars. This made the operation more economical. To study this phase of the problem, sectional labor cost from the operation was plotted as a function of the haulage distances encountered in the room work, comparing two- and three-car systems. The results are shown in Graph 1. For comparative purposes, the writer has assumed development sectional labor cost to be $1.00 per ton. This is the origin point of the curves. What does the graph indicate?

1. In this situation, the two shuttle car system has a cost advantage over the three shuttle car system until the haulage distance exceeds 240 ft.

2. Rooms depth should be extended, wherever conditions permit and separate travelways exist, at least to the limit of trailing cables. Better costs are possible in the three shuttle car haulage system beyond 240 ft.

Failing to realize or determine the productive limits imposed by interference between sectional face operations, the three-car system was being represented by the mine department as cheaper at any distance of haulage.

CHART I

PRODUCTION FROM 50 TON FALLS

Number Required	IE Dept. Est.	Actual
Places	14	14
SC	3	3
Loaders	2	2
Driller	2	1
Shooter	1	1
Total Add'n Men over Stand's Crew	5	3
Total Sectional Labor	19	17
Output (tph)	140	127
Output (tp mhr)	7.4	7.5

CHART II

PRODUCTION FROM 50 TON FALLS

Number Required	O.R. Est.	IE Est.	Actual
Places	9	10	9-10
SC	2	3	2
Loaders	1	1	1
Shooters	2	1	1
Total Add'n Men	1	1	0
Total Sect. Labor	15	15	14
Output (tph)	90	96	93
Output (tp mhr)	6.0	6.4	7.1

The productivity of two shuttle car sections experienced most recently does not bear this out. The mine is actually producing equivalent tonnages at lower cost where the shuttle car haulage is less than 240 ft. The number of available working places is definitely a key to securing optimum production from the section.

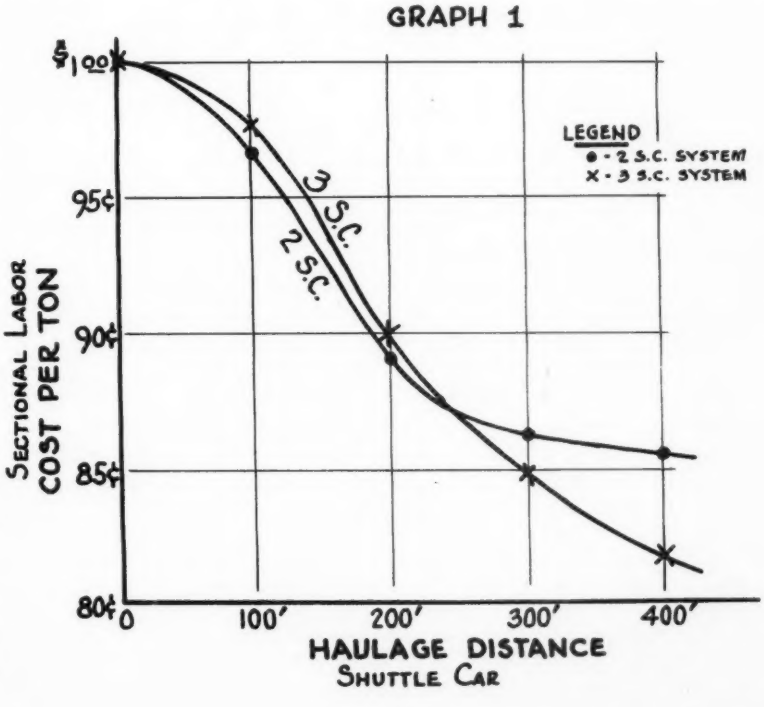
The second point has a prerequisite which cannot be overlooked. Separate travelways or haulage roads must exist. The application of three shuttle car haulage system generally can easily be installed in conventional mining section with six or more headings where haulage distance requires them. Behind continuous mining machinery, three shuttle cars provide a limited advantage since generally only one or two haulageways are maintained. In operational situations, where haulageways are so restricted, management would do better to adopt a change in mining plan which would make the necessary travelways available, or invest in a different type haulage equipment such as extensible conveyors in order to optimize the production equipment.

Basic Measurement Important

The basic measurement on which the mine's own determination was researched should be identified. The company employs the standard data method. This is a firm and reliable foundation for measurement which is a prerequisite for submitting any systems data to the simulation techniques of operation research. Run-of-mine data cannot assume an air of reliability by its admission to a digital computer. The measurement must provide necessary control values from which research, at any level, may originate. Standard data effectively handles the variables which exist within the operational cycles. The time consumed in "cranking out" solutions when the problems are complex is lengthy and often the solution is paper bound. This type study may not be economical. If not, the recourse may be operation research.

Figure 3 in Dr. Koenigsberg's article will serve to graphically illustrate a mathematical representation

GRAPH 1



of the cyclic haulage system. The two shuttle car system (outlined left side plate) can be described as in balance when the time required for shuttle car "A" to travel (TE) from the interchange point to the loader, be loaded (LT), then return to the interchange point (TL) equals the time consumed by shuttle car "B" by travel (TL) from interchange point to the unloading site, dump (DT), then return to the interchange point. This can be written as follows:

TE + LT + TL for "A" = TL + DT + TE for "B"

Loading Cycle = Dumping Cycle

In the three shuttle car operation (shown on right side plate) the cycle will be balanced when (with the symbols shown above except as "C" third shuttle car is added):

TE + LT + TL for "A" = TL + ½DT for "B" = ½DT + TE for "C"

Loading Cycle = One-Half Dump Cycle = One-Half Dump Cycle

The balanced haulage system exists only as a passing situation in the ever advancing or retreating plan of mining operations. Mining plans and equipment impose a restrictive influence upon a haulage system. Within mining plans, travelways and travel distance are vital in the solution of a haulage problem. Equipment range, speed and payload add other inconstant values. The simplest phase of mine haulage, at best, is complex.

In Dr. Koenigsberg's figure 8, the layout indicates the similarity in principle between shuttle car haulage and track haulage. The latter case being even more complex as a result of seven units gathering cars to one collecting point. Each unit has been defined as to cars per trip (inside loop) and cycle time (at base of loop) per trip. The approach to solution parallels that taken in shuttle car systems.

It is the writer's opinion that operation research techniques are applicable to mining's haulage problems. What is the need? It is a case of "To each, his own" for it would be difficult to find duplicate haulage systems in every detail in the coal mining industry. The formulation of analysis would likely be the same but require different values and different variation of these values. If a "hunt and peck" system is assumed for solving the problem, management retards its progress and leaves the possibility of success based on its decisions largely to chance. The cyclic type operations are manifest in mining systems. Each operational cycle being interrelated to the performance of other operations. This complex nature requires the use of some evaluation of formerly ignored variables, certainly a better appreciation of most variables than the use of averages or mean values. However, it must be kept in mind that operations research is not problem-seeking, but problem-solving. Finally if management, from top to the lowest level, can accept this approach with greater confidence and responsibility, industry can only profit by its use.

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Skid bars mounted on Hendrick Wedge Slot Screens protect wedge slot profiles from large ore chunks, greatly reducing wear caused by abrasion. That's why Hendrick screens can stand up under the tremendous punishment of heavy-duty mining. The protection given by the skid bars assures you of a better dewatering job and longer screen life. In addition, the C-12 or CH-12 profile bars have thick, parallel head flanges which maintain uniform openings through the life of the screen. For further information, write direct to Hendrick today.

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When you need a centrifugal dryer,
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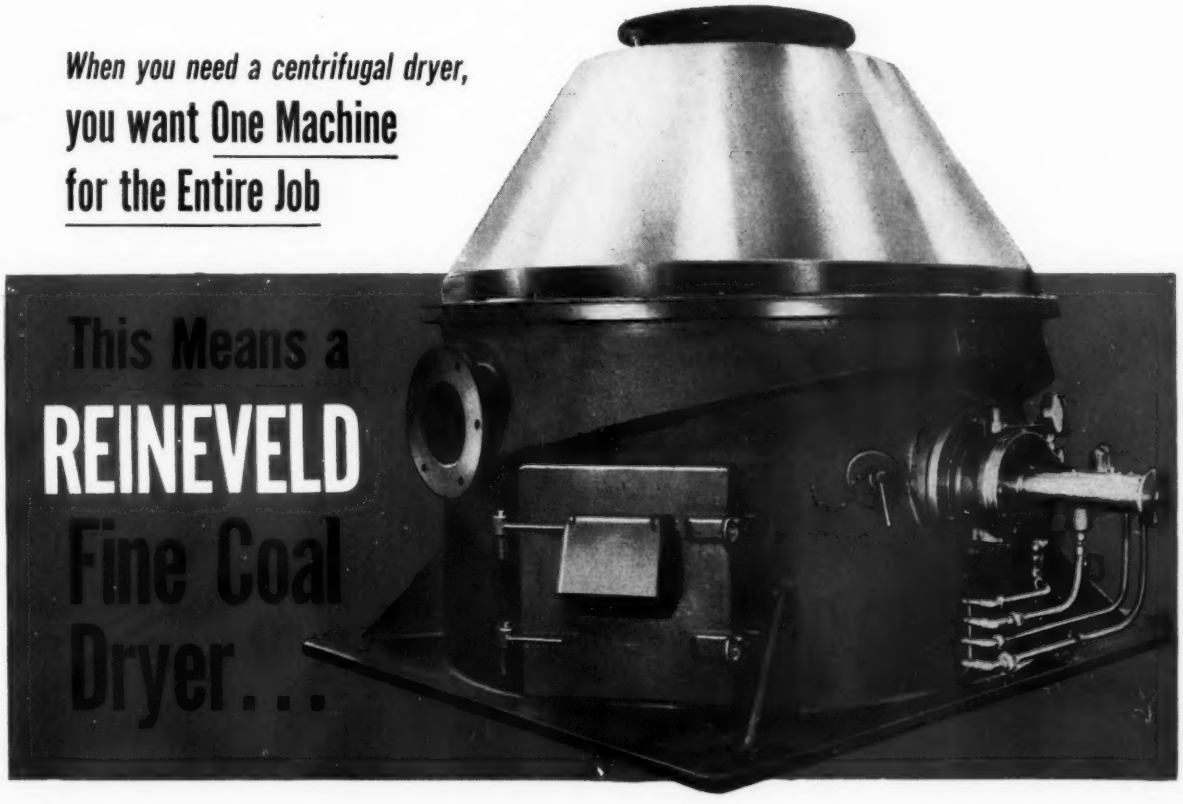

- The Reineveld has greater flexibility and accepts any particle size of feed **from 3/8" all the way down to 0"** without requiring prior classification or desliming.
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Reinevelds are used by many of the leading coal companies. Among the six top-ranked coal producing groups, four are using a total of 47 REINEVELD FINE COAL DRYERS

GROUP OR COMPANY	1956 Tonnage	% Chan 1955 to 1
Pittsburgh Consolidation Group* . .	31,724,380[1]	+ 13.3
U. S. Steel (c)	22,889,712	– 9.0
Peabody Group*	21,698,493[10]	+ 59.9
Island Creek*	14,782,405[6]	+ 44.9
Eastern Gas & Fuel*	10,472,274[4]	+ 12.
Pittston Group*	10,391,461[3]	+
(c)	9,507	

Excerpt from Keystone Coal Buyers' Manual

Heyl & Patterson INC.

Operators' Corner

CLEATS INCREASE BELT TONNAGE

UNDER normal operating conditions, a belt that slopes over 25°-30° will not do an efficient job of hauling, particularly with materials such as slag or gravel. As a result, tonnage falls off because the material tends to slip or roll back on the belt.

It is now possible to correct this situation by the application of REMA cleats, a product of Western Germany that is distributed throughout the United States by Flexible Steel Lacing Co. These rubber cleats can be applied to rubber conveyor belting in the field without heat or cumbersome equipment.

Cleats can be placed at 90° (crosswise on the belt) . . . in the form of chevrons or V's . . . along the sides of the belt to act as guide rails . . . or in any pattern desired. They are affixed to the belt by a self-vulcanizing process.

Basically, the application procedure involves six steps:

(1) Outline the area of belt to which cleat is to be applied.

(2) Roughen this area with sandpaper, a wire brush or wire wheel, and remove debris.

(3) Brush a thin coat of vulcanizing fluid over prepared area.

(4) Cut a strip of rubber sheeting to the same width and length of cleat to be applied, and place over top of roughened area.

(5) Apply thin coat of vulcanizing fluid to underside of cleat, and also over the rubber sheeting.

(6) After tackiness has gone, place cleat over prepared area and pound the top surface along its entire length. Belt can be put into operation immediately. However, if exceptionally heavy materials are being conveyed, it is recommended that belt be left idle overnight.

Rubber cleats that can be applied to a belt on the job prove effective in minimizing back-sliding of material

The distributor of these rubber cleats claims that they have done much to increase belt life and efficiency, especially when used as a replacement for metal cleats. A typical example is the experience of a county road commission. The material being conveyed was slag, an extremely sharp and abrasive material that is not conducive to long belt and cleat life.

Metal cleats formerly used often caught on obstructions, resulting in extensive belt damage. Delivery of belts with molded rubber cleats generally took considerable time, and if for some reason the cleats were torn off, they could not be replaced. Replaceable rubber cleats, on the other hand, could be applied to the belt *on the job* and the equipment returned to service within a few hours. Maintenance men applied the first rubber cleats about one year ago and the results have been satisfactory. Subsequently, four other belts were equipped with these cleats.

The effectiveness of rubber cleats in minimizing back-sliding of material on a sloping belt is illustrated by the experience of Chandler Materials Co., Tulsa, Okla. In this case, the material being conveyed was a fine limestone sand in a slurry. The company's difficulty was caused by a belt that sloped 22½°. The material kept sliding back. To overcome this rubber cleats, 12 in. long, were applied across the belt on four ft centers. Results were gratifying. The cleats prevented the material from sliding back, and the capacity of the belt was increased considerably. For example, it previously carried about 250 tons of material in a nine hour day, whereas now it is averaging around 485 tons for the same period.

Rubber cleats help in upgrading the tonnage performance of conveyor belts hauling many types of materials. The thing that stands out most is the ease with which they can be applied to a belt in the field, a feature that makes them a valuable addition to any belt maintenance kit.

RIPPING DIGGING

This CAT No. 977 Traxcavator increased production 30%

Dixie Mines, Inc., one of the nation's largest producers of hi-grade mica, was using a competitive machine until last year in one of their mines. This mine, near Heflin, Alabama, is under the direct operating supervision of the firm of Bailey and Van Horn. Then a Caterpillar No. 977 Traxcavator with No. 6 Ripper was put to work. Result:

"By using the No. 977 we have upped our production 30%," says Joe W. Bailey, resident manager. "It loads faster, lifts faster and is mobile. Besides working the overburden and the mica bearing pegmatite, we use it to feed the mill at night, build dams, maintain roads and many other jobs. It's a good all-around machine—and we're happy with the freedom from down time and low cost of operation."

The No. 977 rips the tough pegmatite then loads it into trucks. During a ten-hour day, production averages 500 cu. yd. The material is put through a jaw crusher, washed and screened, leaving a concentrate of mica as residue.

The No. 977 works at such a money-making pace because it's built from the ground up as a loader-excavator, not just a tractor with bucket attached. About 26 sq. ft. of ground-gripping track provide tremendous traction to crowd the 2¼-yd. bucket full every time, get away fast.

In addition, operator comfort means that this fast pace is maintained. He has a high seat with excellent visibility of all bucket positions. Controls are easily reached—bucket control a one-hand operation.

Your Caterpillar Dealer has three sizes of Traxcavators in his line. Get the full story on them today. Have him demonstrate on your job. Count on him for fast service and quality Caterpillar parts.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

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THE NO. 977—POWER AND VERSATILITY FOR MINING

As Viewed by HARRY L. MOFFETT of the American Mining Congress

WITH Democratic majorities in both Senate and House approaching those of the Roosevelt era, a substantial realignment of Committees is in the cards after the 86th Congress convenes January 7. Practically every piece of legislation must win Committee approval before it can be voted on by either branch of Congress, and the majority party is expected to insure strong control over legislation by generally reshuffling Committee membership to reflect the nearly two-thirds Democratic majority in both Houses.

In the past Congress, Democratic Committee majorities were as a rule so slim that the defection of only one or two party members could give the Republican members of a Committee control of legislation under consideration. This situation should arise rarely if at all during the next two years.

As a result, there is a distinct possibility that many legislative proposals, particularly those involving heavy fund outlays, may meet with Presidential veto. Vetoes were a rarity during the past four years of a Republican Administration and a Democratic-controlled Congress.

The outlines of the approaching contest are suggested by a 12-point legislative program which Senate Majority Leader Johnson (Dem., Tex.) has said he would press. This program includes action on housing, urban renewal, depressed areas, water resources, airports, and interest rates—all of which precipitated clashes with the Administration during the 1958 session, and all of which tend to raise the costs of Government.

WILDERNESS SYSTEM OPPOSED

Representatives of the Western mining industry and other natural-resource industries expressed strong opposition to establishment of a National Wilderness Preservation System at a series of field hearings held last month by the Senate Interior Committee.

Legislation which would place not less than 55 million acres of Federally owned or controlled land and water areas, most of it in the West, in such a system has been introduced by Senators Humphrey (Dem., Minn.), Neuberger (Dem., Ore.), and Douglas (Dem., Ill.). The measure, actively supported by wilderness and other outdoor societies, provides that "the preservation of the wilderness shall be paramount" with respect to lands in the System. For all practical purposes it would prohibit the future development or utilization of any mineral or other natural resources of these lands.

★ ★ ★ ★ ★ ★ ★

Washington Highlights

CONGRESS: Make-up substantially changed

WILDERNESS BILL: Western hearings

NATURAL GAS: Import application denied

BARTER PROGRAM: Revived, expanded

LEAD - ZINC: International study group

OIL IMPORTS: Controls being revised

FLUORSPAR: Import study begun

TUNGSTEN: Tariff Commission issues report

URANIUM: Mill capacity increased

★ ★ ★ ★ ★ ★ ★

Vigorous opposition to the bill was expressed at earlier Washington hearings by the American Mining Congress and other industry associations, including the U. S. Chamber of Commerce.

The November field hearings were held in Bend, Ore.; San Francisco; Salt Lake City; and Albuquerque, N. M. At the San Francisco session, the Mining Association of Southern California opposed the measure, noting that "there are at present sufficient laws on the books to take care of any needed withdrawals for parks, monuments and other proper recreational areas. . . . Our main objection, of course, is to the exclusion from these areas of both mining for hard minerals and drilling for hydrocarbons."

In a statement at the Salt Lake City hearing, the Utah Mining Association declared that such legislation would squelch economic growth of the West by cutting off resource development. This view was supported by Idaho State Mine Inspector O. T. Hansen, who testified that enactment of the bill "is likely to bottle up many minerals of high military and strategic values."

GAS IMPORT APPLICATION DENIED

In a ruling of particular interest to the coal mining industry, the Federal Power Commission has denied the application of a midwestern gas company to import Canadian natural gas to serve the North Central United States, on the basis that the company failed to show that it could obtain an adequate supply of gas from Canada. At the same time, the FPC denied competing applications of two other gas companies to serve the same area with natural gas from United States sources. All three companies were given permission, however, to file new proposals at a later date.

"We think that, assuming the Canadian authorities will eventually permit its export, Canadian gas should and inevitably will be made available to this and probably other areas of this country," the FCC said in its decision. "Even though . . . we cannot authorize the importation of Canadian gas at this time, we are confident that in due course, when more

satisfactory commitments are made and supplies more adequately shown, we will find it possible to authorize its importation."

The FCC apparently was referring to an interim report on natural gas made public a short time earlier by the Canadian Royal Commission on Energy. In this report, the Royal Commission recommended that the Canadian Government ignore the commitment of the now-defeated Liberal Government that a Canadian company be allowed to export gas surpluses to the United States, and further suggested that a close appraisal of the gas reserves available be made before any export permit is issued.

BARTER PROGRAM EXPANDED

The Federal Government has revived the barter program, stalled since early in September, with a new list of 26 minerals which the Department of Agriculture will accept from foreign sources in exchange for surplus farm commodities.

Aim of the program is the exchange of perishable farm products acquired by the Government under price-support activities for strategic minerals and other materials produced in friendly foreign countries, chiefly for the supplemental stockpile. However, President Eisenhower has ordered the Agriculture Department to handle the revised program so that barter deals, which are consummated through private traders, "will expand the total exports of agricultural commodities without disrupting world markets."

In compliance with this order, the rules governing the expanded program are designed to limit barter arrangements with countries which otherwise might purchase U. S. farm commodities through normal trade channels.

The 26 minerals on the new barter list are:

Crude aluminum oxide abrasives, antimony, asbestos (amosite and crocidolite), bauxite (Surinam, Jamaica, refractory), beryl (hand cobbed), bismuth, cadmium, chromite (metallurgical, refractory, chemical), columbite, cryolite, diamonds and bort, ferrochrome, fluorspar (acid, metallurgical), lead, manganese (various battery and chemical grades), mercury, mica (muscovite block, film and splittings), nickel, palladium, quartz crystals, ruthenium, selenium, silicon carbide, tantalite, tin, and zinc.

GENEVA LEAD-ZINC MEET HELD

Meeting for the second time within two months, representatives of more than 30 nations interested in stabilizing free-world production of lead and zinc concluded a Geneva, Switzerland conference last month. It was announced that formation of an international study group under United Nations auspices may result from the conference deliberations.

The United States delegation participating in the international conference was headed by Thomas C. Mann, Assistant Secretary of State for Economic Affairs. Industry advisers in attendance were Charles E. Schwab, chairman, Emergency Lead-Zinc Committee; Richard A. Young, vice president, American Zinc, Lead & Smelting Co., and Harold E. Lee, vice president, The Bunker Hill Co.

Formation of a study group was generally expected to be the outcome of the Geneva parley. While such a group may give further consideration to methods of bringing world supplies of lead and zinc into balance with consumption, early establishment of a system of export or production quotas on an international basis is not generally foreseen.

OIL IMPORT CONTROLS BEING REVISED

The Administration will shortly issue a revised voluntary oil import program. The President's Advisory Committee on Energy Supplies and Resources Policy has been hassling over changes in the program for several months. The principal point of difference within the Committee has been over the extension of voluntary quotas to include numerous oil products and also residual oil.

At this writing, it is understood that the new program not only will restrict imports of crude oil but may also apply to a number of refined products. The question of limiting imports of residual oil is holding up issuance of the revised plan. Some Cabinet officers favor such restrictions but others, principally the Secretaries of State and Defense, are said to oppose them. Meanwhile, a number of Senators and Congressmen have called upon the Committee and the President to include residual oil restrictions in the revised program.

OCDM TO STUDY FLUORSPAR IMPORTS

At the request of domestic producers, the Office of Civil and Defense Mobilization will conduct an investigation of fluorspar imports to determine whether they are threatening to impair the national security.

The recently amended national-security provision of the Trade Agreements Act requires the OCDM, upon application, to undertake such studies, and, if a threat is found, to promptly notify the President. If the President agrees with an OCDM finding of threatened impairment of national security, he may curb imports in any manner he deems necessary to remove the threat.

OCDM earlier had undertaken similar investigations of imports of cobalt and tungsten ores and concentrates, also at the request of a domestic producer.

TUNGSTEN REPORT ISSUED

A comprehensive report on "Tungsten Ore and Concentrates," prepared at the request of the Senate Finance Committee, has been issued by the U. S. Tariff Commission.

Culminating an investigation instituted by the Commission nearly nine months ago, the 67-page report includes a description of the domestic industry, domestic and foreign production over a period of years, imports and consumption, prices, the impact of Government purchase programs, and factors affecting competition between domestic and imported tungsten ore and concentrates.

In conducting investigations of this type, authorized by the Tariff Act of 1930, the Tariff Commission does not make any recommendations as to whether import controls are needed to safeguard the domestic industry, but merely reports its findings.

The study had been sought by domestic tungsten producers, nearly all of which are currently shut down as a result of prevailing low world prices for this strategic metal.

URANIUM MILLING CAPACITY BOOSTED

The Atomic Energy Commission has approved a plan to increase uranium milling capacity in Wyoming by approximately 1700 tons per day. Under the plan, two new mills will be constructed and three existing ones will be expanded. The new plants will be located in the Gas Hills area.

AEC officials said that contracts have not yet been negotiated with the mills for purchase of the additional uranium.

Applications for expanded uranium milling capacity in Wyoming have been in the hands of the AEC for many months.

BOOK REVIEW

LITERATURE ON URANIUM AND THORIUM AND RADIOACTIVE OCCURRENCES IN THE UNITED STATES. (Part 5)

Prepared by Margaret Cooper, geologist, U. S. Geological Survey. Published by the Geological Society of America, 419 West 117th Street, New York 27, N. Y., $6.75

The Geological Society of America has published as its Special Paper No. 67, "Bibliography and Index of Literature on Uranium and Thorium and Radioactive Occurrences in the United States. Part 5: Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and Wisconsin."

This 472-page book contains a bibliography, gazetteer for the States, geographical index, and subject index. Part 5 is a key to the literature on deposits in which uranium, thorium, and radioactive minerals are found in the northeastern United States. For many of the States there is also much detailed information on the geology and general mineralogy of pegmatites, coal beds, sandstones, shales, beach sands, and other formations in which the uranium and thorium have been reported.

Remittance must accompany orders.

personals

Charles A. Wight has been named president of Freeport Sulphur Co., and **Pearson E. Neaman** has been made chairman of the executive committee.

Wight succeeds **Langbourne M. Williams,** who became board chairman as well as president in 1957. Williams will continue to be chairman and chief executive officer. A graduate of Yale

C. A. Wight

P. E. Neaman

University in 1922, Wight joined the Freeport organization in 1948.

Neaman, formerly senior vice president and general counsel, succeeds Wight as chairman of the executive committee, and will continue as general counsel. A graduate of Harvard College in 1924 and Harvard Law School in 1927, he has been associated with Freeport since 1930 when he became secretary. He was made vice president and secretary in 1945, vice president and general counsel in 1948, and senior vice president and general counsel in 1955.

Erwin Gammeter, a vice president of Paul Weir Co., Inc., of Chicago, has assumed new duties as department head of the company's coal mining mission in South Korea. He took over from **Max H. Forester,** who completed his assignment and is returning to the U. S. after 18 months duty. A. Paul Weir team forms the mining portion of a joint industrial group serving as general advisors and supervisors on economic improvement projects to increase South Korea's self-sufficiency.

Leonard L. Hank has been promoted to vice president of operations for National Gypsum Co., succeeding Wells F. Anderson who died September 21. He will be in charge of the company's 38 plants, mines and quarries, and its purchasing, transportation, engineering and plant industrial relations divisions. Hank has been vice president in charge of manufacturing.

A graduate of the University of Cincinnati's College of Engineering, Hank joined National Gypsum in 1946 as manager of the company's Kalamazoo paper plant. He was named manufacturing vice president in 1956.

William G. Kegel has been promoted to general master mechanic for the California, Pa., Vesta-Shannopin Coal Division of Jones & Lauglin Steel Corp. Kegel, who has been assistant general master mechanic since 1950, succeeds **Ben Walburn,** who has resigned.

Kegel has devoted his entire career to the maintenance of coal mine equipment. He started with Lee Norse Co. of Charleroi, Pa., in 1940, and in succeeding years held positions as an electrician, service man, and foreman of the Mechanical and Electrical Departments. He joined J & L in 1950.

The American Institute of Mining, Metallurgical, and Petroleum Engineers has announced that one of its most distinguished awards, the William Lawrence Saunders Gold Medal, has been voted by the board of directors to **John Ballantine Knaebel,** of Grants, New Mexico, consultant to The Anaconda Co. Presentation will be at the AIME annual meeting in San Francisco, Feb. 15-19, 1959.

The medal goes to Knaebel "for his versatility and courageous leadership in pioneering, exploring, developing and managing highly successful mining ventures as a leader among men—yet one of them."

The William Lawrence Saunders Gold Medal, established in 1927, recognizes distinguished achievement in mining other than coal.

John H. East, Jr., of Denver, Colo., regional director of the Bureau of Mines' eight-State Region III since 1949, has been voted the Department of the Interior's Distinguished Service Award and Gold Medal. The Department's highest honor was conferred in recognition of more than 20 years of achievement with the Bureau in mining engineering, health and safety work, executive administration, and as an author of several publications—chiefly in the field of mine safety.

The citation accompanying East's award describes his "high degree of technical competence, leadership, and ability in formulating programs and welding together an unusually productive, efficient and smoothly operating organization, characterized by excellent employee morale."

Sir Harold Jeffreys of Cambridge University will be a Distinguished Visiting Lecturer at the University of Minnesota during the period April 1 to June 15, 1959. He will present a series of lectures on "Elasticity and its Geophysical Applications," with special reference to recent work in

Sir. Jeffreys

Prof. Mooney

related fields such as rock flow. Jeffreys is well known to persons in the geological sciences as one of the most distinguished mathematical geophysicists of our time.

During Jeffreys' visit, **Harold M. Mooney,** associate professor of geophysics at the University of Minnesota, will be visiting lecturer in the Institut für Geophysik, Eidg. Technische Hochschule, Zurich, Switzerland, under a grant from the American-Swiss Foundation for Scientific Exchange.

Donald D. Harries, prominent Duluth attorney and general solicitor for U. S. Steel Divisions and Subsidiaries in the Lake Superior District for the past 10 years, retired from corporation service on October 31.

Widely known in legal circles throughout Minnesota, Harries holds degrees from Harvard and University of Minnesota. He has practiced law in Duluth since 1922. Harries became asisstant general solicitor for U. S. Steel in Duluth, Minn., in 1948, and later the same year advanced to the post of general solicitor.

Norman L. Deuble has been chosen as the senior metallurgical engineering executive to head an expanded metallic molybdenum development and service task force, which has been formed by Climax Molybden Co. Deuble, a pioneer in metallic molybdenum development, has been relieved of his duties as manager of Metallurgical Development to devote full time to the creation and direction of an enlarged division within the sales department to assist users on developing new applications for the metal, and to offer fabrication and other metallurgical assistance.

William Bellano has been elected president of Gulf Sulphur Corp., of Houston, Texas. He succeeds **Stuart Dorman,** who has resigned.

Bellano, formerly vice president in charge of engineering and purchasing for International Minerals & Chemical Corp., Chicago, has spent his career in the mining industry here and in South America.

A graduate mining engineer from Pennsylvania State College, he was assistant general superintendent of the Volcan Mines Co., in Ticlio, Peru, from 1946 to 1949, when he returned to this country as manager of the Marianna Division of the Island Creek Coal Co., at Huntington, W. Va.

Wm. Bellano

He joined IMC in 1953 as chief mining engineer in the Engineering Division. Bellano served as production manager of the company's Phosphate Chemicals Division at the Bonnie plant before he was elected vice president in charge of engineering.

Richard H. Lewin was recently appointed as president of Lewin-Mathes Co., a division of the Cerro de Pasco Corp. Lewin, formerly executive vice president, succeeds the late Felix S. Dreyer. Lewin - Mathes' activities range from copper smelting to fabrication of copper and brass products.

Herman E. Bakken, vice president of Aluminum Company of America and general manager of Alcoa's refining division, has retired after nearly 40 years of service. **J. Ranald Fox,** formerly assistant manager of the division, succeeds Bakken as manager.

Prominent in pioneering Alcoa's now extensive research and product development programs, Bakken graduated from St. Olaf College in 1915. He joined Alcoa's research staff in 1919 and, after serving in many managerial positions, was elected an Alcoa vice president in 1956.

Fox has held key executive posts in three of Alcoa's alumina refining plants during his 30 years with the company. After graduating from the University of Colorado in 1928, he joined Alcoa at its alumina plant in East St. Louis, Ill. He was production superintendent there when transferred to the company's alumina plant in Mobile, Ala., in 1952. At Mobile, he was assistant plant superintendent until 1955. He was then named project manager of the new Point Comfort (Tex.) alumina plant, and supervised the planning of the project in Pittsburgh until 1957, when he moved to Point Comfort as works manager of the refining plant. In 1957 he returned to Pittsburgh as assistant general manager of the refining division.

Ross V. Seeton, Jr., has been appointed manager of the mining division of Lutah Uranium & Oil, Inc., Roswell, N. Mex. He will headquarter at Edgemont, S. D., where Lutah operates the McLeod uranium mine.

W. H. H. Cranmer, president of New Park Mining Co. was presented the "Award of Distinguished Citizenship" recently on occasion of the 100th anniversary of the founding of Denver, Colo. The veteran mining and oil man, who started his career in the western mineral industry as a youth in the Cripple Creek, Colo., gold district, was cited not only for services to Colorado, but also because of the recognition he has received in the mining field in the United States.

Hugo Riemer has been appointed to the recently created position of executive vice president of U. S. Borax & Chemical Corp. Riemer was also elected to the board of directors of the company, as was **Norman Travis** of London, England.

Riemer is well known in chemical and fertilizer circles in this country, having been with the Allied Chemical Corp. for over 20 years. His last position with that company was as president of its Nitrogen Division.

Currently a director of Borax (Holdings) Ltd., Travis succeeds **D. Abel Smith** who has resigned from the board of directors. He was recently managing director of British Visqueen Ltd., a jointly-owned subsidiary of Imperial Chemical Industries and Union Carbide and Chemical Corp.

— *Obituaries* —

Eugene James Bachman, 68, former vice president of Jefferson Island Salt Co. died October 19 in Louisville, Ky. A native of Illinois, Mr. Bachman had been associated with Jefferson Island for 35 years at the time of his retirement in 1955.

Laidlaw B. Burger, formerly a partner in Tuttle-Burger Co., and later president of L. B. Burger Coal Co., died October 18 at his home in Rochester, N. Y. Mr. Burger, who was 72 years old, retired from business in 1952. He was a 1908 graduate of Yale University.

James Osborn Lord, 66, professor of metallurgical engineering at Ohio State University suffered a fatal heart attack October 13. A 1915 graduate of Ohio State, Professor Lord joined the OSU faculty in 1921 as an instructor. Subsequently, he became a full professor in 1956 and had been associated with the University's Research Foundation since 1941.

Elmer H. Ingle, 32, well-known sales representative of National Mine Service Co. died suddenly October 12 at his home in Indiana, Pa. Mr. Ingle started with National Mine in the Beckley, West Virginia plant in 1949 and was soon advanced to Field Lamp Service in southern West Virginia and eastern Kentucky. Later he became Equipment Sales representative in the Whiteman Division, Indiana, Pa.

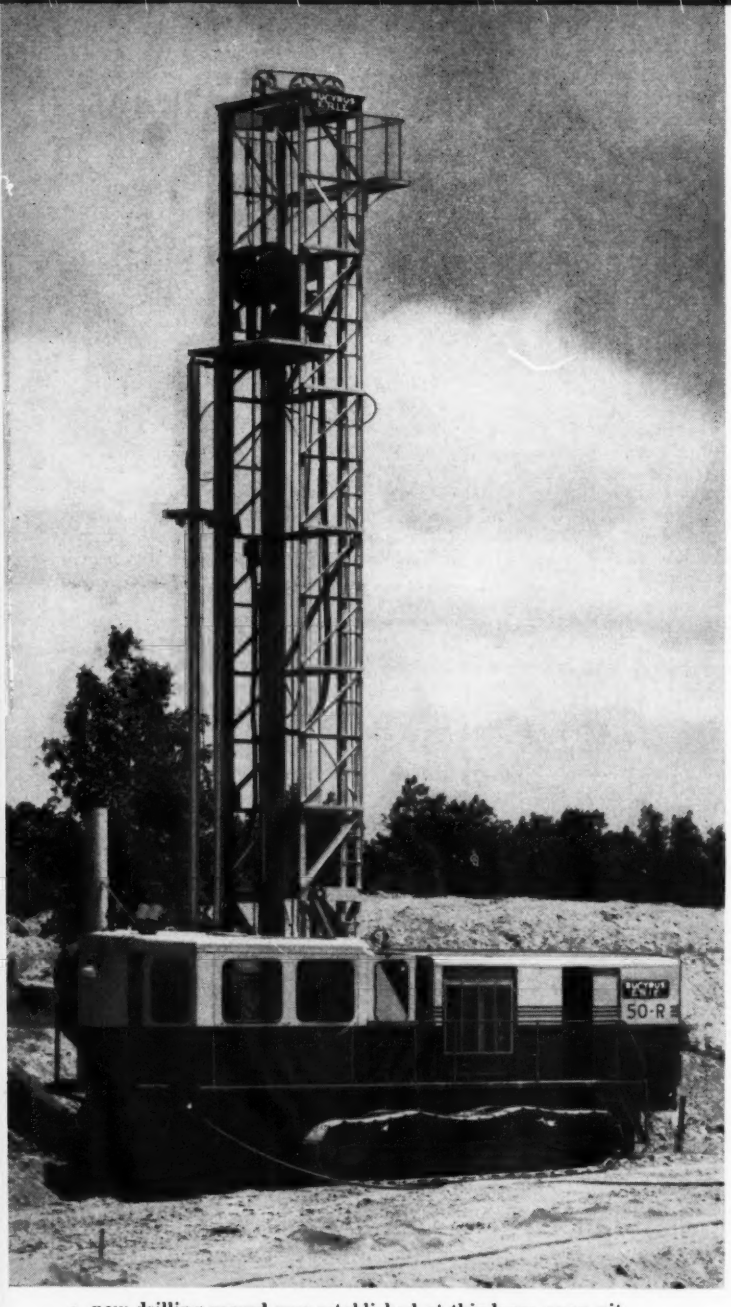
William Westervelt, organizer and long-time president of Copper Pyrites Corp. at Ducktown, Tenn., died October 8 in Knoxville, Tenn. Mr. Westervelt had been retired for 15 years, and was 86 years old.

Ernest Emmons Eddy, 56, well-known mining engineer and manager, died after a month-long illness November 3 in a Salt Lake City hospital. He was district manager for Sunshine Mining Co. in Salt Lake City, a position he formerly held in Denver. From 1955 to 1957 he was mine manager for the company in Blanding, San Juan County, and was also employed by the firm in Spokane. Mr. Eddy was a mining engineer graduate of Washington State College.

Funeral services for **James A. Stokes,** 91, pioneer Joplin mining man were held in Joplin, Mo. Mr. Stokes died October 19. Zinc and lead ores were discovered on a farm owned by Mr. Stokes shortly after the turn of the century, and one of the richest mines in the immediate Joplin area was developed. The property was known as the Bumble Bee Mining Co.

Thomas R. Thornburg, former treasurer of the Philadelphia & Reading Coal and Iron Co., died October 28 at his home near Chestertown, Md. He was 74 years old. Before his retirement four years ago, Mr. Thornburg was a civil engineer with Stone & Webster Engineering Corp. of Boston and New York.

BUCYRUS-ERIE ROTARIES Speed Blast Hole Drilling



A new drilling record was established at this large open pit coal mine in Indiana when the 50-R shown here was put into operation.

BUCYRUS-ERIE rotaries are increasing drilling footage at open pit mines everywhere. Their ability to put down hole fast results from an exclusive combination of features — variable drilling speed and variable down pressure.

For controlled speed, the Ward Leonard variable voltage system gives the operator smooth, instant command over rotation of the drill pipe. He can choose the most efficient speed for a given formation. To meet requirements, he can vary the speed without stopping the drilling operation.

In hard formations, maximum down pressure can be exerted on the bit while the drill pipe is turning slowly. This gives greatest possible penetration.

In soft formations, the operator can increase rotating speed substantially as he cuts down pressure. He can match pulldown force and rotation speed so tools do not advance faster than cuttings are removed. At the same time he keeps up enough air velocity to remove cuttings from the hole.

For the full story on Bucyrus-Erie rotaries, contact Bucyrus-Erie Company, South Milwaukee, Wis. Ask for illustrated bulletins on the 50-R (full-electric rig for drilling 9⅞ to 12¼-in. holes) and the 40-R (diesel or electric rig for drilling 6¾ to 9-in. holes).

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NEWS and views

Kennecott Copper to Buy Assets of Okonite

Plans to affiliate have been announced by Kennecott Copper Corp. and The Okonite Co. Charles R. Cox, president of Kennecott, and R. Stuart Keefer, president of Okonite, announced that a contract has been signed by which Kennecott would acquire through a new subsidiary company the properties, assets, business and good will of Okonite in exchange for shares of Kennecott common stock on a share-for-share basis. The proposal is to be submitted to Okonite stockholders at a special meeting and if approved would take effect immediately.

The arrangement will bring together a major producer of copper and one of the most technically advanced of the independent cable makers. Founded 80 years ago, Okonite is best known for its premium-grade insulated wires and cables furnished for power transmission and distribution, control and signal systems and electronic and communication circuits. Annual sales have averaged $45,000,000 for the past five years.

Interior Department Approves Mine-Drainage Project

Approval of the twentieth anthracite mine-drainage project proposed by the Commonwealth of Pennsylvania under a $17,000,000 State-Federal program for relieving the mine-water problem in the anthracite region has been announced by the Department of the Interior. Designed to remove the threat of sudden flooding in the Underwood and Olyphant mines near Scranton, Pa., the project is expected to cost about $360,000. It will involve moving over 2,000,000 cu yd of spoil-bank material to fill 17 strip pits in which large amounts of water collect after rainstorms.

The Underwood mine, owned by Pennsylvania Coal Co., employs 105 men and produces 100,000 tons of coal yearly. The Olyphant mine, one of the largest in the Lackawanna Basin of the northern anthracite field, is owned by Hudson Coal Co. and produces nearly 500,000 tons annually with a payroll of about 870. Between them, these two mines now pump nearly 8,700,000 gal of water every year.

Approval of this latest project brings funds expended or committed under the cooperative program to more than $6,000,000, half contributed by the Federal Government and half by the Commonwealth of Pennsylvania.

Cleveland Cliffs Installing Slope Conveyor

What will ultimately be one of the world's longest slope conveyors is being installed at the Ishpeming, Mich., mines of the Cleveland Cliffs Iron Co. When installation is completed, the belt, made by United States Rubber Co., will have a center distance of 3791 ft. will carry 700 tph of low-grade taconite ore, traveling at a speed of 460 fpm. Ore will be carried from the twelfth to the ninth levels in the Mather "A" mine, an elevation of approximately 800 ft.

Until the new levels are ready, the belt must help excavate its future location. A short section, held with mechanical fasteners, is now removing materials from below the ninth level. Succeeding sections of the belt will be added as needed. When all of the belting—a total of over 7500 ft—is ready for use, the sections will be spliced together. Two 350 hp motors will power the three-ft wide belt.

American Electric Power Co. Sets Record

The American Electric Power Co. is probably the world's first electric power company to exceed a total generating capacity of 5,000,000 kw. A recently completed 450,000-kw plant at Carbo, Va., not only raised the AEP system's power capacity to a new record plateau, but represents a major contribution to the growth and development of the southwest Virginia area. The $60,000,000 plant is owned and operated by Appalachian Power Co., one of six operating companies of the AEP system.

The plant's two units are expected to consume a total of approximately 1,300,000 tons of coal a year, all of which will be supplied by the Clinchfield Coal Corp. under a long-term contract. Delivery is over a short-haul railroad directly to the power plant from a newly developed mine.

In addition to serving the Appalachian system, the new power plant also will provide power directly to two other AEP System operating companies, the Kentucky Power Co. and Kingsport (Tenn.) Utilities, Inc., by way of newly-constructed 138,000-volt transmission lines.

Coppermines Sale to Cerro Approved

Cerro de Pasco Corp. and Consolidated Coppermines Corp. boards of directors have approved in principle a plan for acquisition by Cerro de Pasco of the assets of Consolidated Coppermines. Such a transaction requires approval by stockholders of both companies, but dates have not yet been set for the meetings.

Under the proposed terms, all of the assets of Consolidated Coppermines, subject to liabilities, are to be exchanged for securities of Cerro de Pasco, with the amount of such securities to be determined by a final value to be placed upon Consolidated Coppermines assets.

Coal Company to Produce Lightweight Aggregate

Clinchfield Coal Co., Division of The Pittston Co., has awarded Link-Belt Co. a contract to design and build a plant to produce lightweight aggregate. The new plant is under construction at Clinchfield, Va., and will use as its raw material the shale from Clinchfield's new Moss No. 3 coal preparation plant which is nearing completion on the same site. Construction of the lightweight aggregate plant is expected to be completed and the plant in operation in January 1959.

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Fletcher to Head UET

Andrew Fletcher, president of St. Joseph Lead Co., has assumed the additional responsibilities of President of United Engineering Trustees, Inc.

United Engineering Trustees, Inc., was incorporated in 1904 for the purpose of advancing the engineering arts and sciences. Its Board is composed of three representatives from each of the five professional societies representing the major branches of engineering—mechanical, civil, electrical, mining, and chemical. Among other activities, the corporation directs the research programs of the Engineering Foundation, which is financed by a fund of over $2,000,000, and also acts in a fiduciary capacity for a large number of joint activities of the major engineering societies.

Proposed New Engineering Center

United Engineering Trustees, Inc., has purchased the block front between 47th and 48th Streets on the United Nations Plaza for the construction of a 20-story, $10,000,000 Engineering Center. At this new location, the Engineering Societies Library can greatly expand the services that have already made it one of the finest public engineering libraries in the world. Furthermore, the five societies of United Engineering Trustees have extended invitations to other engineering societies to unite with them in using the new facilities as their headquarters.

Thoroughly modern in every respect, the new Center (see drawing) will include, in addition to headquarters office space for each group, such facilities as a cafeteria, dining rooms, meeting rooms, and a large memorial hall; suitable for group meetings or for major exhibitions of technical progress. Few, if any, societies or groups in the world will then possess headquarter facilities as impressive in appearance and as efficient in operation as the engineers.

Andrew Fletcher is a past president of the American Institute of Mining, Metallurgical, and Petroleum Engineers, and in 1957, he was awarded the Charles F. Rand Gold Medal of that Society for "distinguished administration in non-ferrous mining and metallurgical enterprises." He is also chairman of the Industrial Hygiene Foundation of America, vice president and treasurer of the American Mining Congress, and past president of Lead Industries Association.

Fletcher succeeds Walter J. Barrett of New Jersey Bell Telephone Co., who has been president of UET since 1955, and who is also the retiring president of the American Institute of Electrical Engineers. In commenting on the new Center, Mr. Fletcher said:

"The progress made during the administration of Walter Barrett in planning the new United Engineering Center, securing the site opposite the United Nations, and launching the fund raising drives is an inspiration to unified effort such as the engineering profession has not had before. Under the leadership of Willis F. Thompson and the Real Estate Committee, detailed plans for the building are being developed by Shreve, Lamb and Harmon, architects. It is expected that actual construction will be started in 1959, upon the completion of the fund-raising campaign in which $5,000,000 will be obtained from business and industry, and $3,000,000 from the 200,000 individuals who constitute the Engineering Societies membership. Already more than half the $8,000,000 goal has been subscribed."

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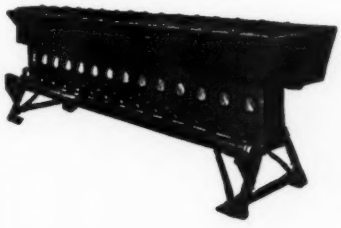

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Calumet & Hecla Purchases Interest in Alabama Company

Calumet & Hecla, Inc., has purchased a majority interest in the Alabama Metallurgical Corp. of Selma, Ala. Brooks & Perkins Incorporated of Detroit, Mich., retains its present holdings and will purchase the balance of the Alabama equity. The announcement was made by H. Y. Bassett, president of Calumet & Hecla and E. Howard Perkins, chairman of Brooks & Perkins.

Upon completion of a new plant to be constructed in Selma, Alabama Metallurgical will produce magnesium metal from dolomite ore by the ferrosilicon process. Dolomite properties of the company are located near Selma.

Illinois Mining Institute Annual Meeting

A. G. Gossard, vice president and general manager of Snow Hill Coal Corp., was elected president of the Illinois Mining Institute at its annual meeting held October 24 at Hotel Abraham Lincoln, Springfield, Ill., succeeding H. C. Livingston, president of Truax-Traer Coal Co.

The newly elected vice president for the coming year is H. C. McCullom, vice president in charge of underground operations for Peabody Coal Co.

George M. Wilson, head of Education Extension at the Illinois State Geological Survey, continues as secretary-treasurer of the Institute.

Honorary life memberships were awarded to D. W. Buchanan, Sr., of Old Ben Coal Corp. and Gilbert H. Cady, senior geologist, Emeritus, and former head of the coal section of the Illinois State Geological Survey.

From left to right: George M. Wilson, secretary-treasurer, Illinois Mining Institute; J. W. MacDonald, vice president of engineering, Old Ben Coal Corp., afternoon session chairman; W. A. Weimer, chief engineer, Peabody Coal Co.; J. J. Reilly, vice president, Hanna Coal Co.; Elmer Citron, Pittsburg-Midway Coal Co., and Gerald von Stroh, director, mining development committee, Bituminous Coal Research

Speakers at the morning session were: A. T. Secor of the Shawnee Plant, T.V.A., and John Koopman of Electric Energy, Inc., on "Fuel Requirements for Modern Power Plant Operation," George Eadie of the University of Illinois on "Ventilation Practices in Illinois Coal Mines," and Henry Hebley of Consolidation Coal Co. on "Water Pollution."

The afternoon session discussed problems of large-scale strip mining. W. A. Weimer of Peabody Coal Co. described the "Operation of the River King Mine." James J. Reilly of Hanna Coal Co. spoke on the "Economics of the Large Mine Car." Elmer Citron of the Pittsburg-Midway Coal Co. talked on "Advantages of Overland Belt Transportation." Gerald von Stroh of Bituminous Coal Research spoke on "Automation and Remote Control Mining."

Arthur Secord, professor of Speech and Area Services Development at Brooklyn College, Brooklyn, N. Y., speaker at the evening banquet, talked about "How to Tell What You Know."

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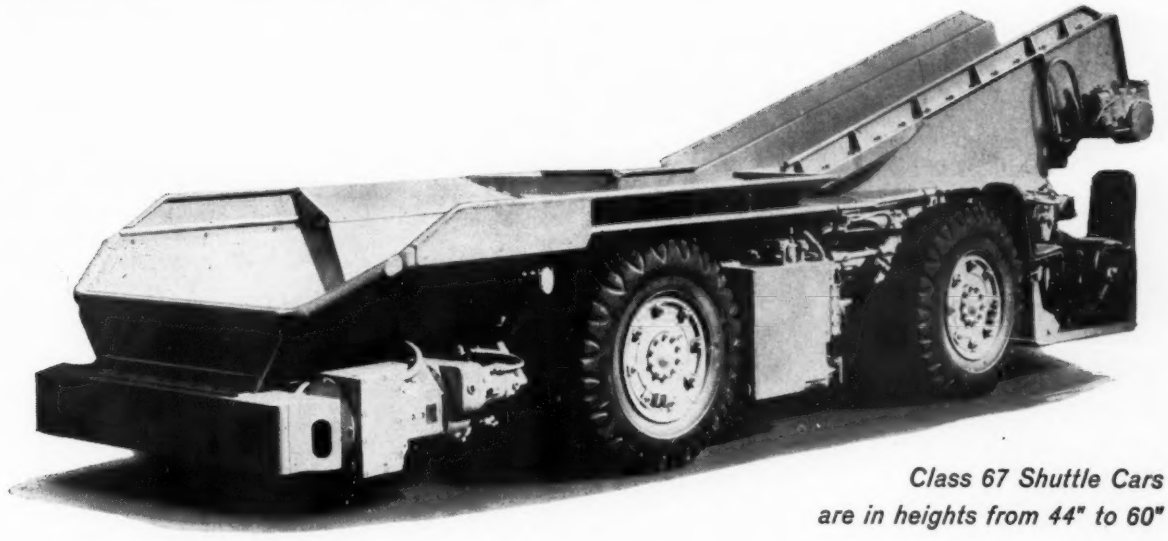

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Payloads can be matched to your mining height, ranging from 4.6 tons to 9.2 tons; 88″ or 96″ wide. Fast loading and unloading are easy for the operator as he has the aid of the variable speed, hydraulically driven discharge conveyor. Can be reversed instantly to clear jammed lumps.

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ALSO . . .

A new coal mine at New Eagle, Pa., is expected to be in production within a few months. Known as the Maple Creek mine, the operation is a project of the United States Steel Corp. and will have an annual production of 500,000 tons. A major part of the construction program now in progress includes an 800 tph coal cleaning plant and an unloading dock complete with coal barge unloading facilities for handling coal to be washed in transit. The new mine is about nine miles upstream from U. S. Steel's by-product coke plant at Clairton and much of the coal is expected to be used there.

Magnolia Petroleum Co., Southwestern affiliate of Socony Mobil Oil Co., Inc., recently announced it has completed arrangements to buy oil and gas properties in Louisiana's Lake Washington field from Freeport Sulphur Co. Total consideration to be received by Freeport is approximately $100,000,000 in cash, part of which will be paid by Magnolia and part from the sale of a reserve production payment. Charles A. Wight, president of Freeport, said that Freeport would continue development of oil and gas properties in Louisiana, Texas, Oklahoma and Kansas.

A 69,000-lb dragline bucket, one of the largest in the world, has recently been completed for Central Ohio Coal Co., Zanesville, Ohio, and will be used in coal stripping operations. Built by Electric Steel Foundry Co., the 35½-yd bucket is specifically designed for use on a Marion Super 7800. Average width of the bucket is 11 ft 2-in., height from the ground to arch, 13 ft 5 in. and the over-all length is 18 ft 9 in. Two and three-quarter-in. wire rope will be used for the hoist cable and the drag cable will be 3⅛-in. in diameter.

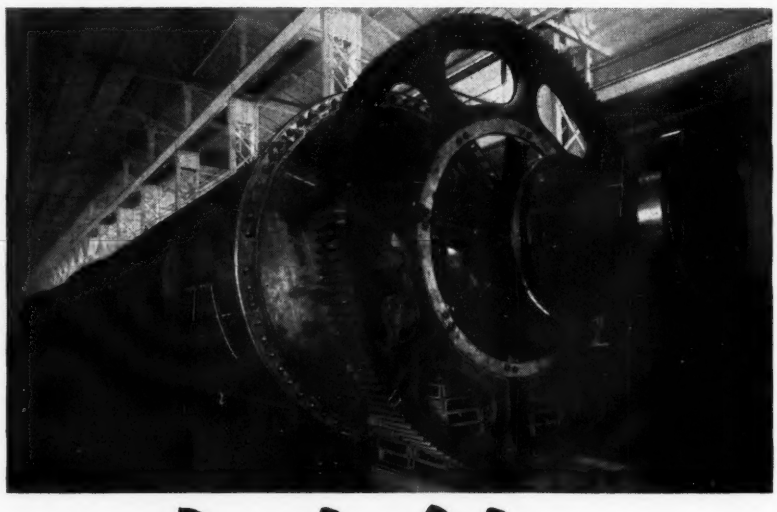
Bethlehem Steel Corporation's new Grace mine, near Morgantown, Pa., will ship its first iron ore before the end of 1958. All the ore will be sent to blast furnaces at the steel company's home plant in Bethlehem, some 50 miles away. The ore isn't as rich as the Great Lakes ore the Bethlehem plant has been using and will have to be processed at the mine to bring it up to par. The extra processing costs, however, reportedly are more than offset by the shorter haul to Bethlehem.

The 40th Anniversary Meeting of the Central Pennsylvania Coal Producers Association was held at Bedford, Pa., October 2-3. A. F. Tegen, president of General Utilities Corp., spoke at the banquet Thursday evening, October 2, on "The Coal Producer and the Electric Power Industry."

"Engineer Tax Men," a publication just released by the U. S. Internal Revenue Service, tells about engineers in the Internal Revenue Service. It describes the work they do and how they feel about it as a career. Copies may be obtained by writing to the Assistant Commissioner (Technical), (Attention: T:S:E), Internal Revenue Service, Washington 25, D. C.

St. Joseph Lead Co. has resumed operations at its southeastern Missouri lead mines to a five-day week basis from four days.

South East Coal Co. has started construction of a new coal processing or handling plant at Ravena, Ky., to handle 15,000 tons of coal daily. It will require two years to build. Coal will come chiefly from three South East mines, the balance from other producers.



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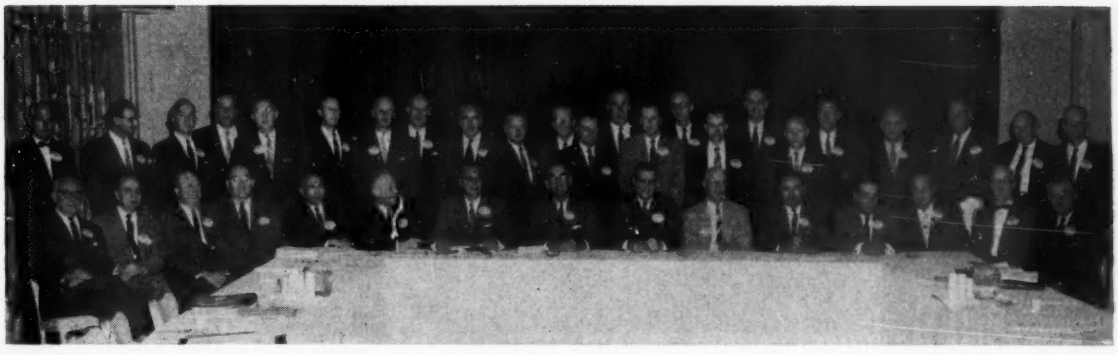

Confidence in coal's future growth highlighted this meeting of industry leaders as they gathered to formulate the program for the 1959 Coal Show of the American Mining Congress

Program Committee Meets

To Outline Technical Sessions for 1959 AMC Coal Show

Primary objective of the Program Committee for the 1959 AMC Coal Show at its meeting in Pittsburgh, November 13, was the selection of topics and speakers for next year's Coal Convention to be held in Cleveland May 11-14. The meeting reflected the confidence of all present in the future growth of the industry, and under the Chairmanship of E. P. Humphrey, President, Stonega Coke & Coal Company, the Committee drew up a program designed to highlight the latest advances in coal mining technology and safety.

A convention session on Continuous Mining will feature ventilation and dust control, haulage and roof control. Fire fighting and methane monitoring will be emphasized at the Safety session. Two sessions on Strip Mining will stress highwall recovery, the economic aspects of large stripping equipment and trends in haulage. A-c power and the advantages of high distribution and utilization voltages will be featured at a session devoted to Underground Power.

A session to consider Management and Cost Controls will emphasize personnel training and testing and the achievement of cost control through industrial engineering. Coal preparation men will concentrate on fine coal recovery and preparation plant design. Preventive maintenance and maintenance training will be fully covered in the discussions on Equipment Maintenance. The final convention session will concentrate on Thin Seam Mining, getting into both continuous and conventional mining in thin seams. A general outline of the technical program appears below.

Of special interest to the industry at next year's Convention will be the biennial Exposition of mining equipment. A record-breaking "Coal Show" is assured, with more companies exhibiting more products for use in our Nation's coal mines than ever before.

Plans are also being made for a full schedule of entertainment for both mining men and their ladies, centered around the annual Coal Miners Party—that wonderful, gala affair that has attracted so much attention in the past. Then too, there will be the customary round of individual parties and impromptu get-togethers.

Only once every two years does this great opportunity come to the Coal Industry—the opportunity to hear industry leaders describe the latest in coal mining technology and to see such a wide panorama of the newest coal mining equipment. Applications for hotel accommodations have been sent to the industry, but if you have not received yours, write directly to Louise D. Perkins, Director, Hotel Reservation Bureau, 511 Terminal Tower, Cleveland 13, Ohio. This is one meeting you can't afford to miss!

Preliminary Program

MONDAY MORNING
Continuous Mining

MONDAY AFTERNOON
Open

TUESDAY MORNING
Underground Power
Strip Mining

TUESDAY AFTERNOON
Safety

WEDNESDAY MORNING
Open

WEDNESDAY AFTERNOON
Coal Preparation
Management & Cost Control

THURSDAY MORNING
Strip Mining
Equipment Maintenance

THURSDAY AFTERNOON
Thin Seam Mining

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And the use of the one-man-operated Wemco Mobil-Mill for Heavy Media Separation is more and more a standard for optimum results.

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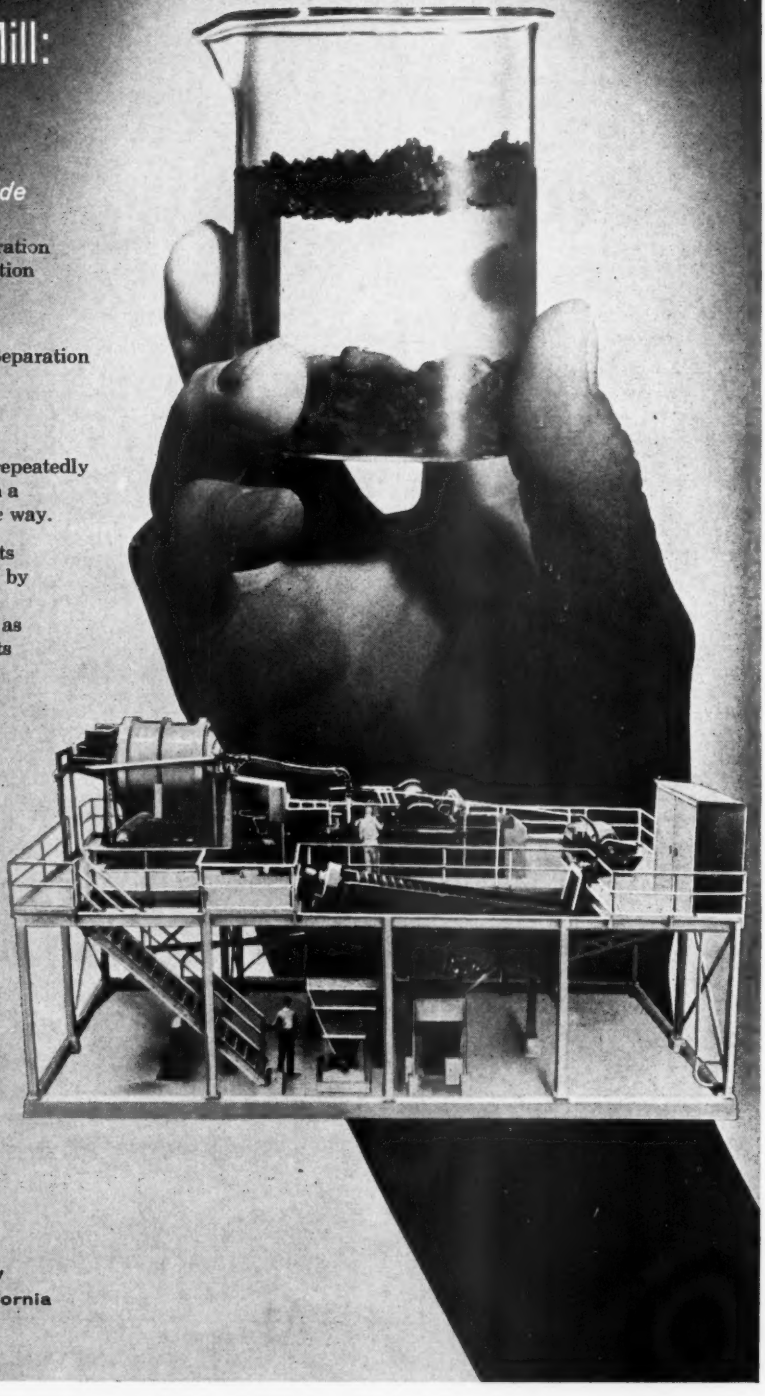

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A sintering plant with an output of 2400 tons a day has been put into operation at the Ashland, Ky., plant of Armco Steel Corp. Engineered and constructed by Dravo Corp., the plant was built primarily to agglomerate iron ore from Labrador, but will also be used to reclaim large stockpiles of flue dust and sludge which have accumulated during the past 16 years.

Eccles No. 6 mine of Eastern Gas & Fuel Associates, near Beckley, W. Va., reopened October 1 after being closed ten months to permit construction of a new coal preparation plant. The mine employs approximately 150 persons. The new plant, capable of handling the mine's annual capacity of 350,000 tons, was built to enable Eccles No. 6 to produce a better quality of coal to meet competition in today's market.

Chesapeake & Ohio Railway's new coal-loading dock at Toledo, Ohio, has gone into full-time operation. The $7,000,000 mechanical shiploader is capable of handling 6000 tph of coal from railroad cars into vessels. It will dump two railroad cars simultaneously and feed coal to the various compartments without the vessel having to shift its position. C&O's coal-loading capacity at the port is expected to be increased 40 per cent by the addition.

The Ohio Reclamation Association, representative of the State's surface mining operators, recently conducted a "show-me" visitation of strip mine areas in eastern Ohio for the State strip mine Board of Review, various other State and Federal officials, and industry representatives from four States. The association has been responsible for the planting and seeding of more than 44,000 acres since 1945, including the planting of over 24,000,000 trees and the seeding of 17,000 acres to grasses and forage crops. In addition it maintains aerial survey and mapping services, engages in management and harvesting, advises on land use and practices to prevent water pollution, and carries on its own fish stocking program.

Morton Salt Co. has purchased the 103-acre Garland Copley Farm southwest of Rittman, Ohio, as a source of underground salt. Additional land adjacent to the farm is being purchased for the same purpose. Present plans call for the drilling of wells next spring to recover the salt.

Mallory-Sharon Metals Corp. has announced development of four new titanium alloys which the company believes will greatly enlarge potential uses for the metal in the aircraft and missile industry.

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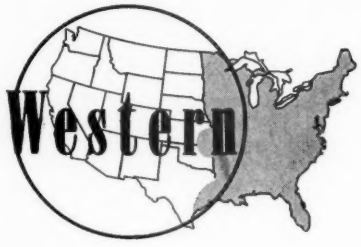
NEWS and views



Bunker Hill Plans Fertilizer Plant

The Bunker Hill Co. has announced its intention to construct a $10,000,000 fertilizer plant in the Northwest which is scheduled to go into production by July, 1960. John D. Bradley, president of Bunker Hill, said the production of fertilizer was an important and logical part of the company's planned diversification program.

The plant is scheduled to have an annual capacity of 200,000 tons of fertilizer products, which would make it one of the largest in the Northwest United States. Possible sites are Kellogg, Idaho, and the Kennewick area of Washington.

The fertilizer will be manufactured from Bunker Hill's own sulfuric acid, a by-product of the company's lead and zinc reduction plants at Kellogg. Present acid production is 100,000 tons a year, and this production can be substantially increased.

The Bunker Hill president emphasized that the fertilizer plant was in addition to the company's modernization and expansion programs announced in January of 1957 and currently in progress at Kellogg.

Merger of Polaris into Hecla Set

Stockholders of Hecla Mining Co. and Polaris Mining Co., an affiliate, voted at separate meetings in Spokane to approve the merger of Polaris into Hecla on the basis of an exchange of stock. Holders of Polaris will receive one share of Hecla capital stock for each six Polaris shares held. Polaris is also an associate of Sunshine Mining Co. in certain mining ventures.

L. J. Randall, Hecla president, also announced the company has taken a 60-day option to buy 184,000 shares of Lucky Friday Silver-Lead Co. Lucky Friday mine, east of Mullan, Idaho, is the newest major producer in the Coeur D'Alene mining district of northern Idaho. Hecla will make a study of the mine to determine whether the option should be picked up. There are 1,306,479 Lucky Friday shares outstanding.

Underground Nuclear Explosions

The U. S. Atomic Energy Commission is exerting pressure to exempt underground nuclear explosions for industrial purposes (see *Mining Congress Journal*, November, 1958) from any general ban on nuclear weapons testing.

Plans for the Plowshare Program, a project sponsored by the AEC to study the feasibility of using nuclear explosions for peaceful applications, are unchanged. All paper studies are going along as planned, and the blast is still scheduled for late spring or summer, 1959. Actual detonation, however, depends on what agreements are made at Geneva, Switzerland, during current negotiations, or what status the negotiations have reached by the time the blast is ready. If there is a possibility that the blast might disturb nuclear weapons control negotiations, it may be postponed.

AEC officials are confident industrial test explosions will be exempted. They believe there is no more reason now to ban the use of nuclear explosions for industrial applications, than there would have been to ban the use of dynamite after World War I.

As to cheating by using industrial blasts as weapons tests, AEC officials say this is not a major problem. It is easy to distinguish between the two: for one thing, the degree of instrumentation of a weapons test is far greater. Also, observation teams could be assigned to tests to make sure the tests were kept within specified limits, or the whole research problem turned over to a United Nations' group.

Herb Green Wins Le Roi Contest

More than 4,000 guesses add up to a lot of cards—and a lot of letters. That's why we're using this ad to announce the winner of our "bit guessing contest" which we held at the 1958 AMC Exhibit in San Francisco recently.

The winner of the deluxe outdoor barbecue is Herbert C. Green, general superintendent of the Diamond Springs Lime Co., Diamond Springs, California. His guess was 17,105. And a good guess it was, for there were 17,099 CRD bits exhibited.

So, congratulations Mr. Green! And to the more than 4,000 other contestants—better luck next time, and thanks for your participation.

LE ROI
Division of Westinghouse Air Brake Co.
Milwaukee 1, Wisconsin

U-Milling Expansion Lined Up

As reported in the June 1958 issue of *Mining Congress Journal*, an Atomic Energy Commission study of marketing problems arising from the October 28, 1957 announcement of a commission policy to limit further expansion of domestic concentrate production, disclosed that as of November 1, 1957 five areas had either no market or an inadequate market. The estimated minimum requirements for additional mill capacities in these areas were placed at the following figures:

Areas	New Mill Capacity (tpd)
Southeast Texas	600
North Dakota-South Dakota (Lignites)	600
Wyoming	1700
Colorado Front Range ...	200
Nevada (Austin)	200
Total	3300

Related to these figures are the following developments:

The Atomic Energy Commission has reached a "substantial" agreement on price for uranium concentrates to be produced by the recently formed Palangana Corp., a joint affiliate of Columbia Southern Chemical Corp. and Union Carbide Corp., which seeks erection of a 750-tpd uranium mill in Duval County, Tex., near San Antonio.

International Resources Corp. has submitted a proposal to the AEC offering concentrates at a competitive price from uraniferous lignite deposits near Bowman, N. D. Reserves are estimated as sufficient to justify building a 600-tpd mill.

The 1700 tpd breakdown for the Gas Hills of Wyoming is tentatively set as follows: Federal Uranium Corp., in association with Rado-Rock Resources and Gas Hills Uranium Corp., will build a new multi-million dollar mill in the district, and will run a total of 522 tpd of ore. Union Carbide Nuclear Corp. also will build a new mill and will run 492 tpd. Western Nuclear Corp. will expand from its present rate of 440 to 845 tpd. Fremont Minerals Co. will expand from 550 to 724 tpd, and Lucky Mc Uranium Corp. will be increased from 825 to 1002 tpd. This arrangement will give the Gas Hills District 3585 tpd of uranium mill capacity.

The AEC has requested the Cotter Corp., which operates the only Front Range uranium mill, 2½ mi south of Canon City, Colo., to submit a detailed proposal for expanding its plant to a standard 200-tpd operation. Nineteen uranium producing properties along the Front Range have applied to have their ore processed in the Cotter Plant, and 12 to 14 will develop known ore deposits if the already requested mill addition is approved by the AEC.

In Austin, Nev., Apex Minerals Corp. seeks to build a 200-tpd uranium mill which would be completed in the early spring of 1959. The AEC has reached an agreement on price with Apex.

Therefore, "limited" expansion (about 3300 tpd) of uranium milling for the domestic industry through December 31, 1966, seems to be pretty well lined up.

ALSO . . .

The nation's largest uranium mill, near Grants, N. Mex., will begin operating in December, Kerr-McGee Oil Industries, Inc., disclosed recently. The company is principal owner of Kermac Nuclear Fuels Corp. which is

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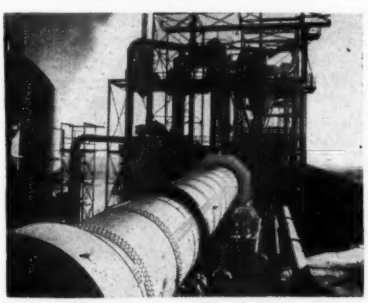


At Eagle-Picher Company's new $2,500,000 Lovelock, Nev., diatomaceous earth plant, cone-shaped process cyclones are supported in the open-air steel structure in the background. The nine-ft diam by 120-ft long, oil-fired rotary kiln in the foreground is one of the largest in use in the industry. The plant will produce 36,000 tons of natural, calcined, and process calcined filter aids for the industry annually. Designed and constructed by Kaiser Engineers, this is the second such plant placed in operation by Eagle-Picher in Nevada.

SILICOSIS STUDIES UNDERWAY IN METAL MINING

Courtesy of the Department of Health, Education, and Welfare

AS a result of hearings of the 84th Congress on certain bills relating to health and safety in the mining industry, the Congress of the United States in July 1958 appropriated to the Occupational Health Program, U. S. Public Health Service, special funds for silicosis studies. These funds will permit the expansion of an environmental study, now being jointly conducted with the Bureau of Mines in metal mines starting in the Western States, to include limited medical studies. Participation in these studies is purely voluntary, and the Public Health Service is urging the full cooperation of the operators and employees.

Full-scale studies of silicosis in the mining industry have not been made in the past 20 yrs, and in the light of newer medical knowledge, there is need for a current appraisal of the situation. A statistical study by the Public Health Service indicates that silicosis is a continuing problem in the metal mining industry. Data collected over a five-yr period (1950-1954) revealed that, out of a total of 10,152 cases of silicosis, there were 1637 cases in the metal mining industry.

These findings raise three important questions: (1.) Are these cases the result of pre-control exposures, in view of the long latent period for the development of silicosis? (2.) Are they accounted for by the failure to apply controls universally? (3.) Are the silicosis cases occurring because of the inadequacy of present controls?

The cooperation and participation of the mining companies is being sought to answer these questions.

Engineering studies in representative metal mines in the Western States were begun by the Bureau of Mines and the Public Health Service in March 1958. These studies involve the determination of the concentration, particle-size, and composition of air-borne dust, and the analysis of air-borne dust and dust-source materials for free silica. To correlate these data with the medical studies, average dust exposures are being calculated for each occupation and operation. Ventilation measurements are also being made at various types of mining operations to determine the adequacy of air movement and its effect on dust and fume concentrations. In addition, general background information on health practices, mining operations, and the sources and kinds of exposures to health hazards is being obtained at each mine studied.

The medical phase of these joint field studies was started by the Public Health Service in November 1958. A representative sample of employees in various sizes and types of metal mines will be examined to determine the occurrence and degree of silicosis and the presence of other lung diseases.

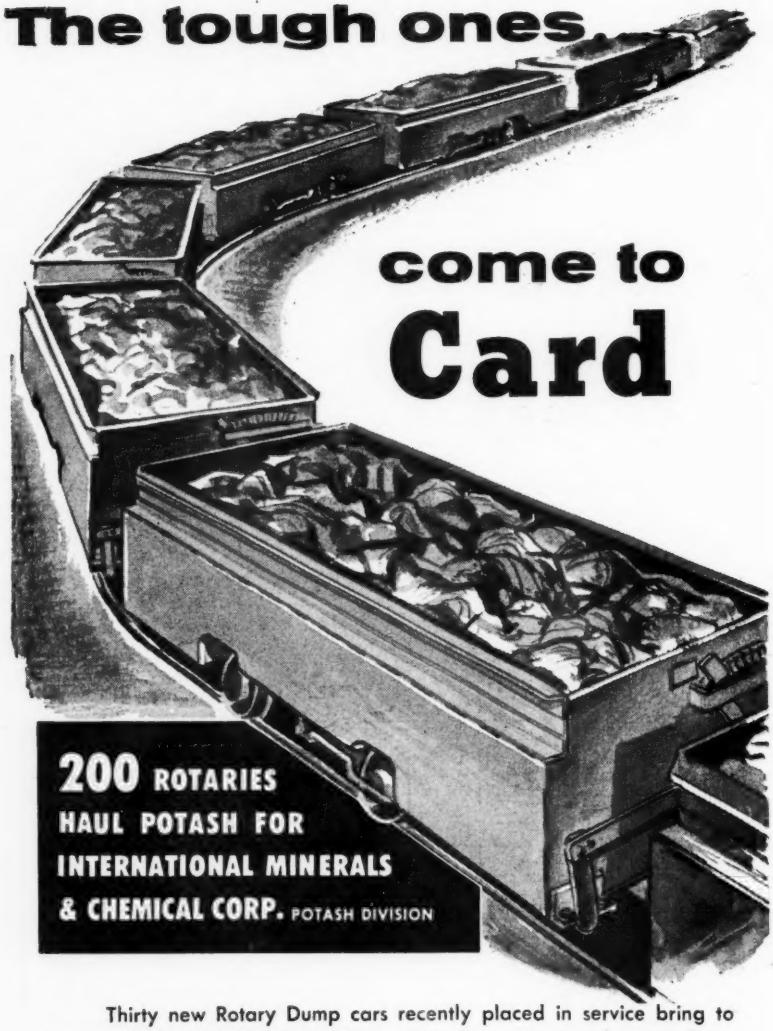
The medical examination will be limited to a brief medical history, a full-size 14 by 17 in. X-ray film of the chest, and three short, simple tests of lung function or breathing capacity. It will also include an occupational listing of all jobs ever held by each employee. Thirty to forty men will be examined per day, requiring from 15 to 30 min. for each employee.

The examinations will be made in an X-ray truck and a house trailer at the mine sites. Representatives of the Public Health Service and the Bureau of Mines will visit each mine well before the arrival of the medical survey team to discuss the proposed survey with mine management.

The medical findings on individuals will not be revealed to the employee, management, unions, or others outside the Public Health Service. An exception will be made only when the X-ray film reveals a condition that needs immediate medical attention, such as suspected cancer and tuberculosis. In such cases, the employee's personal physician may be notified by the Public Health Service if so authorized by the employee.

No reports on individual mines will be issued, nor will the data be available for inspection. A report on the over-all findings will be issued by the Bureau of Mines and the Public Health Service in such a manner that individual mines and employees cannot be identified.

The tough ones...



come to Card

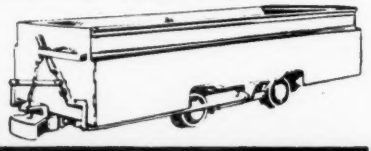
200 ROTARIES HAUL POTASH FOR INTERNATIONAL MINERALS & CHEMICAL CORP. POTASH DIVISION

Thirty new Rotary Dump cars recently placed in service bring to an even 200 the CARD Rotary Dump Mine Cars now in underground use at Carlsbad. Potash does not give the impact punishment CARD cars are taking in so many hard rock operations, but conditions are still tough.

Trains are long; haulage distances constantly increase; grades grow steeper. To keep in full operation economically, the cars have to be easy rolling, strong of frame, and solidly built against mild corrosion. All wheels are Timken bearing equipped and live rubber pads are used instead of conventional steel springs. They are 152 cu. ft. in capacity, struck measure, and track gauge is 42".

Aside from a heavier draft gear to meet the requirements of steeper grades and heavier trains, today's cars are little changed from those in the original order. Four re-orders over a period of years prove customer satisfaction at International Minerals & Chemical Corp.

You, too, can customize your haulage with an economical CARD design. Our engineers can furnish an efficient car to meet your most difficult specifications.



C.S. Card Iron Works Co.

2501 WEST 16TH AVE.
DENVER, COLORADO

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developing several mines to provide ore for the Grants mill. The mill will have a capacity of over 3500 tpd.

Union Carbide Corp. has completed acquisition of Globe Mining & Milling Co., controlled by Darby Hand and Page Jenkins, of Casper, Wyo. Globe controls about 1½ million tons of uranium ore in the Gas Hills District where Union Carbide Nuclear Corp., a division of Union Carbide, proposes construction of a mill.

The American Zinc Institute has published a beautifully illustrated 100-page booklet intended to present in concise form, some of the basic facts concerning zinc in order that its importance, its processes of manufacture, its properties, and its applications may be better understood.

New and unfamiliar aspects of zinc in its applications are presented. Older and established facts are restated to include modifications in concept that may have arisen since earlier editions were released. The booklet is available from the Institute at 60 East 42nd St., New York 17, N. Y.

A 1700-ft deep, 16-in vent hole was drilled successfully into one of the main drifts of Clear Creek Mining Co. at Idaho Springs, Colo., opening the way for extraction of new ores by providing sufficient fresh air for mining operations. The hole was drilled by Minerals Engineering Co., of Grand Junction, and Franklin & Perry Drilling Co., of Ozona, Texas. In addition to acting as a duct for air flow, the hole also serves as an entrance for electric power lines.

Manganese Reduction Corp. has begun reconditioning and equipping a pilot plant for the start of a manganese mining operation in a former gold mill near Leadville, Colo. A new patented process for extracting manganese from the area's ores will be used. Manganese has been available in the Leadville area during 60 years of mining operations, according to officials of the firm, but extraction costs have been too high for a profitable operation.

A $350,000 plant and equipment expansion program, scheduled for completion by next spring was announced by Texas Aluminum Co. at Rockwall, Tex.

Two development programs, aimed at producing coal at lower costs, have been started at Independent Coal and Coke Company's Carbon County, Utah, properties. These projects involve mining from a different seam in the Castle Gate mine, and driving a 3400-ft haulage tunnel through coal to

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connect the Kenilworth mine with the Castle Gate property. The connection of the two mines will permit a reduction in haulage costs and consolidation of operations.

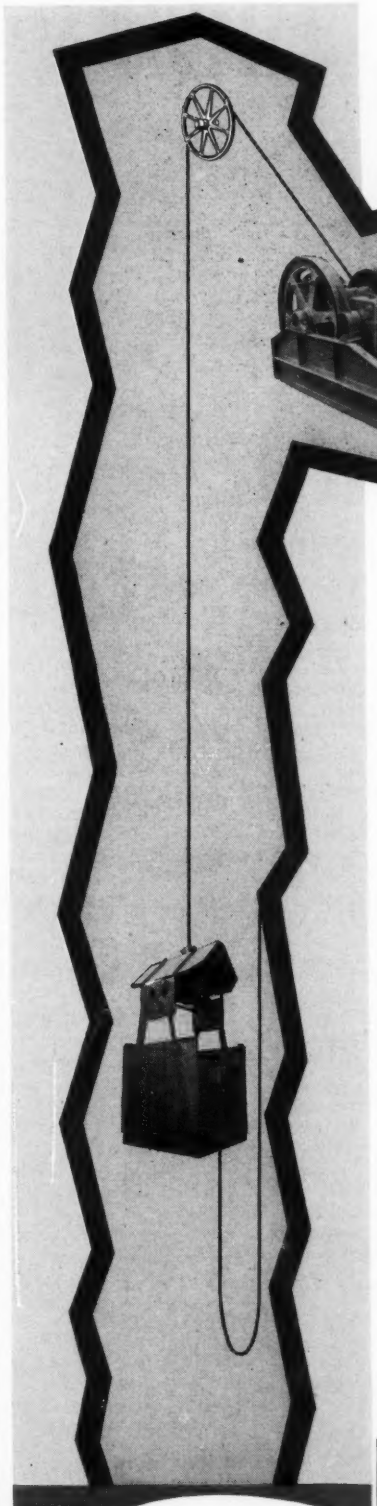
Satisfaction with present and prospective operations at the Wah Chang Corp. Texas City tin smelter was expressed recently by Rep. Clark Thompson (Dem.-Tex.). "I am impressed with the results made thus far," Thompson said. "It is evident that the smelter can be operated by private enterprise without government subsidy or cost of any kind to the taxpayers."

Employees of Homestake-New Mexico Partners and Homestake-Sapin Partners voted against union representation in National Labor Relations Board elections held at the two companies' uranium mines and mills near Grants, N. M.

A group of Japanese officials, representing important steel and mining companies of Japan, have been completing studies this fall in the Bering River coal fields in Alaska on the possibility of mining coking coal. It is reported that various phases of a possible large mining and shipping operation in the Cordova area are being investigated.

A mushroom farm, 200 ft below the surface of the earth in an abandoned coal mine 20 miles south of Santa Fe, N. M., is being run by Luke Roy, a former New Yorker. He has been at it four months and can't fill the orders that come in at $3.50 per lb. Roy may have one of the best-paying coal mines in the state. He thinks mushroom raising is easy in a mine like his. "I've got a beautiful strain of pink mushroom that is much more succulent than those pale white ones you get all the time."

Some uranium alloys belong to a group of substances called super-conductors which have the remarkable ability of permitting an electric current, once started in them, to flow in undiminished strength forever. Long a scientific curiosity, some types of super-conductors are beginning to find practical application in midget computers of the type used for airborne control of rockets, missiles and other space vehicles. Super-conductivity occurs at very low temperatures—in the range close to absolute zero which is 459° below zero Fahrenheit.



SEMI-AUTOMATIC

Vulcan DENVER

HOISTING

Proves Economical In Inter-Level Service Shaft In Arizona Copper Mine

A two-compartment service raise between levels at an Arizona copper mine uses a semi-automatic Vulcan installation which eliminates full time use of two hoist operators and two cagers, and complies with existing mine laws. Selector switches interlocking with geared limit switches and other safety controls permit cage operation from either level or from the cage. A set of by-pass switches permit the lowering of long material suspended under the cage simply and safely.

The Vulcan-Denver hoist is actually a 6,000 lb. two speed winch, with worm gear drive and grooved drum to give 115 F.P.M. high speed and 57 F.P.M. low speed cage travel. Total time between levels is less than 75 seconds. The features of Vulcan design and construction in this case are the same rugged, dependable characteristics that have made Vulcan-Denver hoists and slushers famous for economy and long service throughout the world.

An adaptation of this equipment is driving raises in iron mining. Initial operation by remote control more than doubled the Feet-Per-Man-Shift. No hoist operator needed.

Let us consult on your hoisting application, including remote or automatic control for economical, safe, well adapted operation.

Represented Internationally through DORR-OLIVER, INC., Stamford, Conn., and associated firms.

Vulcan IRON WORKS CO.

IN DENVER SINCE 1891

2960 SOUTH FOX

ENGLEWOOD, COLORADO

manufacturers forum

Tractor Seat Belt

DESIGNED TO INCREASE OPERATOR SAFETY and comfort when working in rough terrain, a seat belt has been made available for Caterpillar-built track-type Tractors,

according to Caterpillar Co., Peoria, Ill. The design of the belt provides secure holding ability, according to the manufacturer, and allows the operator to instantly disengage the belt fastener, which incorporates an over-center latch. The fastener connects the belt at its mid-point, and requires no threading.

Remotely Controlled Continuous Mining System

A MINING SYSTEM PERMITTING MEN TO MINE COAL without going underground has been announced. Joy Mfg. Co. and Union Carbide Corp. have jointly announced the signing of an agreement that gives Joy the right to manufacture, use, lease and sell a remotely controlled continuous mining system. This equipment was originally developed by Union Carbide Olefins Co., a division of Union Carbide Corp.

Peabody Coal Co., St. Louis, Mo., operated one of the early Carbide-built prototype machines for several months in three of their mines. Final commercial development of these machines is now being undertaken by Joy, on completion of which Peabody expects to place the first commercial machines in operation. According to Joy's president, W. L. Wearly, this is expected to be in about 18 months.

The system is operated by a man at an electronic control center, actuating the mining machine which can penetrate high-wall coal to a depth of 1000 ft or more. The continuous mining machine is equipped with sensing elements which electronically report to the operator outside the mine whether the machine is properly heading into coal. With this information the operator outside the mine electronically guides the course of the machine to follow the coal seam. A prototype machine reportedly has proven capable of advancing an entry at a rate of more than 100 ft in one hour.

The mining machine automatically loads coal onto a heavy duty continuous transport system that follows the machine into the mine and delivers the coal to an outside discharge station. This transportation system is said to be designed to operate in conditions where local roof falls may occur.

Joy is proceeding with the final commercial development of the machine, with the advice and assistance of Union Carbide, at a special department established for this purpose at Joy's Coal Machinery Division at Franklin, Pa.

Both Peabody and Joy believe that this patented system is of great importance to the recovery of high-wall coal and that it will eventually have a substantial impact on the future of the coal industry.

Automatic Compressor Control System

TO CONTINUOUSLY SUPERVISE and check compressor operation and give warnings if malfunction occurs, an automatic compressor control system called "'Tendamatic—the tireless attendant" has been developed by Ingersoll-Rand.

After the start button on "'Tendamatic's console is pressed, the control system takes over, monitoring the compressor's every operation. It reportedly checks air pressures and temperatures, lubricating oil pressure and temperature, and cylinder lubricator operation. It checks the float level in the condensate trap and watches for leaking valves and mechanical failure of running parts. If abnormal compressor operation should occur, the system gives both audible and visible warnings, and indicates what is wrong.

"'Tendamatic is available only on Ingersoll-Rand compressors and can be supplied for machines ranging in size from 100 to 7500 hp. For more information, write Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y.

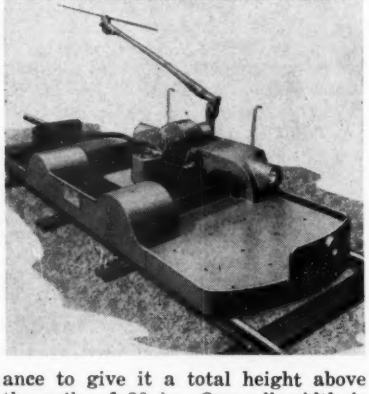
Roof Bit

A CARBIDE-TIPPED roof bit that reportedly is designed to withstand the shock and abrasion of high speed drilling in all types of rock has been announced by Austin Powder Co., Cleveland 13, Ohio. Known as model RDA, it is adaptable to either wet or dry work and is available in two sizes for drilling 1⅜-in. and 1½-in.-holes. Austin Powder recommends the RDA bit for use in coal, gypsum, salt, talc or any other mine where rotary type roof drilling equipment is used.

Inquiries about new equipment appearing in Manufacturers Forum are welcomed. For additional information on any piece of equipment in this section write directly to the manufacturer, or to Mining Congress Journal with name of item and date of issue in which it appeared.

Special Car for Mechanics

DESIGNED FOR SERVICING EMERGENCIES and accommodating five, including the operator, with additional space for tools and equipment, a Mine Mechanic Jitney has been introduced by Lee-Norse Co., Charleroi, Pa. With a body height of 19⅜ in., the Jitney has a 3½ in. ground clear-



ance to give it a total height above the rails of 30 in. Over-all width is 64 in., while the length measures 12 ft. The unit is powered by 7½-hp open type motor, and takes either a 250 or 500 volt d-c trolley. Its axles, both driving, are spring-suspended on anti-friction bearings. Wheels are 16-in. cast steel.

another continuous mining advance . . . newest

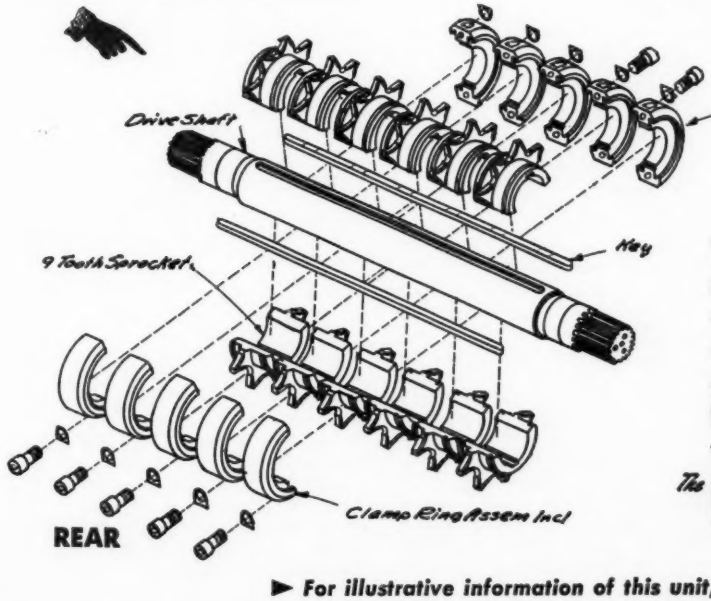
Bowdil MULTI-BAR RIPPER HEAD

IMPROVED

special hard-surfaced Wearing Shoes used in heads of the Cutterbars eliminate maintenance on roller and bearings as formerly used.

REAR OF THE RIPPER HEAD FRAME

Sprockets are clamped to an oversize Shaft, locking Shaft and Sprockets into an integral unit equivalent in strength to a 9" diameter Shaft . . . completely eliminating deflection, the chief cause of bearing failure.



ADJUSTABILITY

Each Cutterbar is independently and easily adjusted thru side ports, making it possible to retain equal tension on all chains at all times.

INTERCHANGEABILITY

All chains are similar in kerf and lacing arrangement for interchangeability as desired. All sprockets are also interchangeable. Chains may be run with or without renewable liners in the Cutterbars to suit your conditions.

RIPPER HEAD ASSEMBLY

includes a special improved design Head Drive Shaft and Sprocket Assembly which makes it possible to renew a sprocket IN MINUTES without removing the Shaft . . . two-piece sprockets, held on the Double Keyed Shaft by special design Resilient Clamping Collars, maintain extreme tension to the Shaft.

► **DEPENDABILITY**

This design MULTI-BAR RIPPER HEAD is made from high grade alloy heat-treated steels. It has been, like all Bowdil products, thoroughly tested under severest conditions over a long period of time before announcement. This is in keeping with the standards of

The **BOWDIL COMPANY**
CANTON 1, OHIO

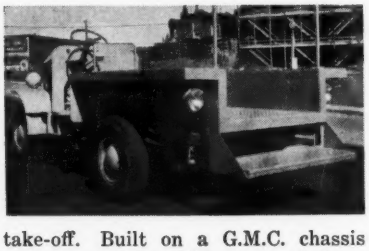
► *For illustrative information of this unit, write or call the factory:* **GLendale 6-7176**

Air-Cooled Diesel and Gasoline Engines

SOLE AMERICAN DISTRIBUTION RIGHTS have been acquired by Hercules Motor Corp. to the German-built "Jlo" line of air-cooled diesel and gasoline industrial engines within the continental limits of the United States. Complete service and parts for the diesels—and for the Jlo series of air-cooled gasoline engines ranging from 1 to 33 hp—will be maintained through Hercules' network of 76 U. S. distributors. The diesel line is offered in two basic models: a 7-hp high-speed 2500 rpm model and a 12-hp, 2000 rpm model. The one-cylinder diesels have cast aluminum cylinder blocks, crankcases and pistons, and weigh 110 and 190 lb respectively. Further information can be obtained by writing to Hercules Motor Corp., 101 - 11th St., S.E., Canton 1, Ohio.

Underground Trucks

WITH A ⅛-IN. THICK STEEL HOOD and ¼-in. steel decking on the bed, Oremaster Utili-Truck reportedly can be used for general purpose flat-bed operations, as a personnel truck, as a parts and tool carrier or, with the installation of a tank, as a special lubrication vehicle. The truck comes equipped with power



take-off. Built on a G.M.C. chassis and powered by G.M. two and four-cylinder diesels complete with exhaust conditioners, the Utili-Truck is available in ¾ to 2-ton sizes on variable wheel bases with choice of two or four-wheel drives and two-wheel drive with no-spin differential. Minimum wheelbase is 76 in. Complete information is available from Ortruc, Inc., 320 S. Grand Blvd., St. Louis 3, Mo.

Rock Drill

A LIGHTWEIGHT rock drill, called the J-30A Jackhammer, has been introduced by Ingersoll-Rand, 11 Broadway, New York 4, N. Y. The blower valve is incorporated into the throttle valve for operating ease and convenience. The J-30A multiple-use backhead design permits conversion from the standard blower style drill to the plain dry or wet styles. Nearly all working parts of the J-30A are interchangeable with those of the earlier J-30. The drill steel centralizer has all its working parts enclosed within the fronthead; this keeps out dust and dirt and virtually eliminates maintenance, according to the manufacturer. The inner parts of the drill are coated with a special rust preventative, which is said to aid in "breaking-in" the tool and to eliminate the need for greasing the parts for storage.

Batteries

FOR MINE LOCOMOTIVES or electric industrial trucks, four new models have been added to the Exide-Ironclad line of high-capacity storage batteries. Reportedly packing up to 45 percent more power in a given battery container, the new models are said to incorporate armored porous tubing and other engineering advances.

One of the new Exide-Ironclads (designated RG), approximately 20½ in. high with cover, has been developed to power mine locomotives and latest models of low-silhouette trucks. Each positive plate of the RG battery is rated at 55 ampere hours. Another model, the MG, which is 18-5/16 in. high with cover, is for use in mine locomotives and low-profile types of industrial trucks. Each positive plate of the MG is rated at 45 ampere hours.

Type TEG Exide-Ironclad, built to meet the demand of new stand-up center-control trucks and new straddle-type trucks with 24-volt systems, has a rating of 95 ampere hours per positive plate. Model MEG is used in standard types of rider and motorized hand trucks. Like the previous type, MEG is 31¾ in. high with cover. Rated at 145 ampere hours per positive plate, the MEG also fulfills increased capacity requirements of high lifting, the special attachments of new straddle trucks and the special new trucks for the steel industry, according to the manufacturer.

Further information can be obtained by writing to Exide Industrial Division, Electric Storage Battery Co., Box 8109, Philadelphia, Pa.

Ripper Head

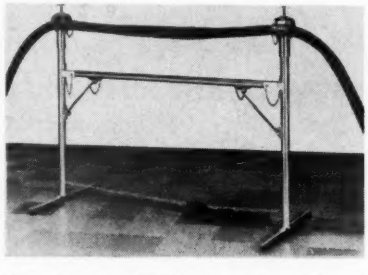
WITH SIX CUTTERBARS in a row, Bowdil Multi-Bar Ripper Head is made from alloy heat-treated steels. Each cutterbar is independently adjusted through side ports, reportedly making it possible to retain equal tension on all chains at all times. All chains are similar in kerf and lacing arrangement for interchangeability as desired, and all sprockets are interchangeable. The ripper head assembly includes a head drive shaft and sprocket assembly which makes it possible to renew a sprocket without removing the shaft. Two-piece sprockets, held on the double keyed shaft by special design resilient clamping collars, maintain extreme tension to the shaft, according to the manufacturer. For additional information write Bowdil Co., Canton 1, Ohio.

Rear Dump

WITH A RATED CAPACITY OF 22 TONS, based on material weighing 2700 lb per cu yd, Model TS-1622 rear dump, variable wheel base trailer is now in production at Easton Car & Construction Co., Easton, Pa. The trailer is designed for use with the Euclid (GMC) Model S-12 Tractor, and will be known as the S-12 Rear Dump. All tractor and trailer tires are interchangeable, and the trailer tires, wheels and brake parts are interchangeable with those on the Euclid Model S-12 Scraper. Effortless maneuverability and smooth, controlled dumping are features of the S-12 rear dump, according to the manufacturer.

Cable Splicing Stand

A PORTABLE ELECTRIC TABLE SPLICING STAND that can be quickly assembled and disassembled has been announced by Austin Powder Co., Cleveland 13, Ohio. Designated as Model H-I, the stand is adaptable to use with all types of cable up to three in. in diameter. Operation of



the H-I is simplified by two hinged pressure clamps that can be set to hinge in the same direction or opposite to each other. These are said to hold the cable firmly in place and to eliminate the threading of cable through the stand. A toggle device located at the bottom of the stand provides tension on the cable after splicing and assures application of a tight jacket. Removable braces are located at all points subjected to heavy stress.

New Products Show

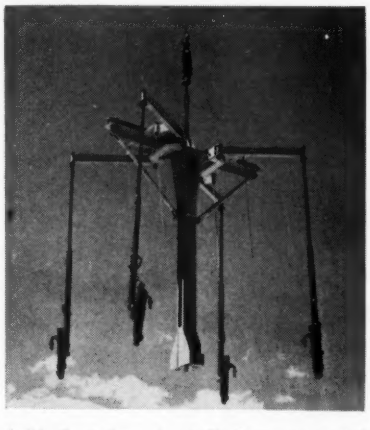
OVER 650 REPRESENTATIVES of the press, financial institutions and Koehring Co. distributors and customers attended a four-day Koehring New Products Show, September 8-11. The Koehring, Parsons and Kwik-Mix divisions presented 33 products, 15 of them new models. Distributors and guests attending this show came from Canada, the United States, and Central and South America.

H. K. Porter and Thermoid Consider Merger

A JOINT ANNOUNCEMENT was recently made by T. M. Evans, chairman, H. K. Porter Co., Inc., and Warren E. Hill, president, Thermoid Co., that the boards of these companies had approved a joint plan of merger, subject to the approval of stockholders of both corporations. Under the merger plan, the surviving corporation will be H. K. Porter Co., Inc., a Delaware corporation. Thermoid common stockholders will receive one share of 5½ percent cumulative sinking fund preference stock of the surviving corporation for each six shares of Thermoid common stock. Holders of Porter common stock and Porter 4¼ percent preferred stock will receive similar shares in the surviving corporation on a share-for-share basis.

Drilling Unit

THE SHAFT JUMBO can be lowered in a collapsed position through a 48-in. square shaft area and set up on a pedestal-type base. Drill carrying arms are raised into position and



held fast by air cylinders extended to wall plates. Drills used are standard air-leg type, or can be mounted, power-fed drifter drills. Spring and plunger locator allows drill arm positioning to drill wall and center holes in shaft bottom. The machine is manufactured by Machinery Center, Inc., Salt Lake City, Utah.

Conveyor Idlers

AN EXPANDED LINE OF BELT conveyor idlers has been introduced by Link-Belt Co. Offered in five series (designated as Series 5000 through 9000) and in widths ranging from 14 in. to 84 in., the line increases the number of idler variations the company manufactures from 38 to 64. In all, the line includes more than 630 different types and sizes. For additional information write Link-Belt Co., Prudential Plaza, Chicago 1, Ill.

— *Announcements* —

Owen G. Jarvis has been named Salt Lake's district manager for **Gardner-Denver Co.** He succeeds **Frank B. Matheson** who is retiring after 48 years of service with the company. Jarvis joined Garner-Denver in 1935 and, after working in Arizona and California mining areas, he returned to Salt Lake where he has represented the firm as a field engineer for the past 20 years.

Herchel M. Richey, general factory manger of **The Timken Roller Bearing Co.,** at Canton, Ohio since 1954, has been elected vice president in charge of Manufacturing, Roller Bearing and Rock Bit Divisions. He succeeds **A. M. Donze,** who retired October 31.

National Mine Service Co. announced the election of **Earl A. Bradley** as vice president. Bradley's new responsibilities will include supervision of the company's three manufacturing divisions—Ashland, Clarkson and Greensburg—together with supervision of sales activities of the Equipment and Distributor Products Division.

James H. Richardson has been appointed manager for the Product Development Department of **Wickwire Spencer Steel Division of Colorado Fuel & Iron Corp.,** Buffalo, N. Y. Richardson has been a contact metallurgist for the company's General Wire Sales Department at Buffalo. He joined CF&I in 1949, and worked in the Wire Products Sales Department in Denver.

Louis G. Helmick, Jr., executive vice president of **Joy Manufacturing Co.,** has been elected a director of the company. Helmick, who joined Joy in 1947, was elected executive vice president in June, 1958. Prior to that time, he had served as vice president and general manager of Joy's Industrial Division.

John E. McGrath, assistant manager of St. Louis sales district of **American Steel & Wire Co.,** has been named manager of Denver district sales office. He succeeds the late H. C. Hoy as chief of the company sales in Colorado, Wyoming, New Mexico, western Nebraska and parts of South Dakota.

CATALOGS & BULLETINS

MINE ROOF BOLTS AND ROCK BOLTS. *Republic Steel Corp., Advertising Division, 1441 Republic Bldg., Cleveland 1, Ohio.* Folder describes the complete line of Republic roof bolts and accessories. Advantages of Republic's exclusive roof bolt certification program, together with Republic's on-the-site engineering service, are pointed out. Installation procedures for both square head and wedge head bolts are described and illustrated. Folder also includes information regarding today's broader application of roof bolting to construction work and hard rock metal mining. Ask for Form No. ADV. 998.

DRILLING TOOLS. *Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.* Revised 24-page catalog No. 358 contains illustrations of all tools and complete specifications of Brunner & Lay carbide drill bits, drill rods, as well as air tool accessories—moil points, clay spades, asphalt cutters, etc. Brochure includes suggestions as to how to make carbide drill bits do more work, last longer and cost less; plus instructions for sharpening and hardening moil points and digging chisels.

FLEXIBLE METAL HOSE CONNECTORS. *Cobra Metal Hose, 5059 S. Kedzie Ave. Chicago 32, Ill.* A large selection of standard flexible metal hose connectors is illustrated, described and individually priced in Cobra Catalog No. 658. It also covers a recently introduced line of wet heat connectors. Included are complete specifications and installation information. Also shown are the company's complete lines of flexible nipples, pipe, pump connectors, vibration absorbers, Freon connectors, gas connectors, space heater connectors, dryer connectors, and water connectors.

PNEUMATIC CONVEYING SYSTEMS. *Day Sales Co., 810 Third Ave. N. E., Minneapolis 13, Minn.* Bulletin M-588 points out how pneumatic conveying systems can reduce plant operating costs and improve plant efficiency. Brochure covers high density (fluidizing type) and low density conveying systems and equipment. Common installation arrangements are diagrammed. Photos show actual installations, basic equipment and accessories. Day research, testing, engineering, fabricating and installation services are briefly described.

PACKAGED GRINDING PLANT. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* An Allis-Chalmers completely aspirated grinding plant featuring a vibrating grinding mill for the processing of a wide variety of materials is described in Bulletin 07B7138. Requiring less than half the space needed by similar capacity equipment, according to the brochure, the "packaged" plant is available at a 25 per cent initial saving due to its small, economical, high-capacity vibrating mill.

LUBRICATION. *Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.* Lubrication Newsletter No. 5, a technical paper covering the effect of lubricants on the "wear in" of new machinery, has been released by Alpha-Molykote Corp. An engineering study of the surface geometry of mating surfaces is included together with a discussion of Coulomb's theory on friction as it applies to the ever-present asperities on machined surfaces. Results of a continuing series of tests on the lubrication of mating surfaces is said to reveal data heretofore unpublished. Test equipment especially developed for this use is thoroughly described, and actual test records are pictured and analyzed.

(Continued on next page)

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ROTARY DRUM FILTERS. *Dorr-Oliver Incorporated, Stamford, Conn.* Entitled "The Oliver Continuous Rotary Drum Fil'er for the Processing Industries," Bulletin No. 7200 describes the designs of the five principal types of rotary drum units and their component parts and details conventional accessories, auxiliaries, media and materials of construction. The 24-page bulletin also includes some 50 photographs of line and wash drawings of various filters and components as well as tables of sizes and capacities of each design.

WIRE ROPE TYPE BELT CONVEYOR. *Jeffrey Manufacturing Co., Columbus 16, Ohio.* Bulletin 948 describes advantages of wire rope type belt conveyor. Illustrations show types of carrying idlers, types of rope stands with return idlers and installation views.

TRUCK CRANE. *Construction Equipment Division, Baldwin-Lima-Hamilton Corp., Lima, Ohio.* Eight-page catalog illustrates and describes the Lima Type 64-T 50-ton capacity truck crane. Illustrated and described in the catalog is the Lima designed carrier construction, "pin-on" type front and rear outrigger boxes, hydraulic power steering, compact rotating assembly, independent plantary boom hoist, main machinery, folding gantry and pin connected boom.

VALVES. *Ohio Brass Co., Mansfield, Ohio.* Condensed catalog pages covers Ohio Brass' complete line of bronze, globe, angle, check, gate, radiator and specialty valves. Material is so listed in the 12 pages that the reader can quickly find pressure ratings, recommended uses, features, and roughing-in dimenions for each valve in a wide range of sizes. Pages can be requested separately or in a set.

FLEXIBLE CORDS AND PORTABLE CABLES. *The Okonite Co., Passaic, N. J.* Combining technical information and a catalog of flexible cords and portable cables, Bulletin 1108 deals completely with Okonite's line of mold-cured Okoprene (neoprene) sheathed cords and cables. The book's main divisions give dimensional data, engineering information, and splicing and terminating instructions.

AUTOMATIC SENTINEL FOR GRINDING MILLS. *Hardinge Co., Inc., York, Pa.* Bulletin AH-480 describes the "Electric Ear," an electronic device for requlating the feed rate to grinding mills, based upon the grinding sound from the mill. The Electric Ear has been modified to include a sound-level recorder, which reportedly makes it possible to keep a 24-hr record of grinding mill operations, and indicates variations that occur which may adversely affect efficient operation.

V BELT DRIVES. *B. F. Goodrich Industrial Products Co., Akron, Ohio.* Entitled "How to Get Longer Life from V Belt Drives," the 12-page manual tells how to select and install V belts, how to detect V belt trouble, diagnose belt failures, and correct drive troubles. A list of valuable tips for proper V belt maintenance is included as well as a suggested inventory survey check list for V belt drives.

FROTH FLOTATION. *Denver Equipment Co., P. O. Box 5268, Denver 17, Colo.* Standard Denver "Sub-A" flotation machines are said to be used throughout the world to recover and clean particles of coal. Bulletin FLO-B37 shows a picture story of the principle, the application and the results of flotation recovery of coal fines. In addition, there is a flowsheet showing typical coal flotation installation.

DIAMOND CORE DRILLS. *E. J. Longyear Co., 76 South 8th St., Minneapolis 2, Minn.* Entitled "Modern Diamond Core Drills and Their Uses," Longyear World No. 7 gives information on the uses of diamond core drills, function of major parts, and illustrates the various types of drills and drilling rigs. Operation of the working parts of a high capacity drill is described.

COAL BREAKER AND CRUSHER. *McNally Pittsburg Mfg. Corp., Pittsburg, Kans.* Bulletin No. 658 gives the latest descriptive information pertaining to all McNally Pittsburg's coal breakers and crushers. Brochure gives a description, photograph, recommended drive data, dimensional drawings and capacities of each unit. The various sizes in which it can be manufactured are also given.

MINE AND INDUSTRIAL TRACKWORK. *Bethlehem Steel Co., Bethlehem, Pa.* Catalog No. 470 describes Bethlehem's complete line of track items for rails of 20 to 100 lb. per yd, made in accordance with American Mining Congress Standards for mine track. Some manufacturer's standard and AREA designs are included for use on sidings and in industrial plants. These are particularly applicable to tipple yards and similar loading-point installations.

AUTOMATIC REDUCED VOLTAGE STARTERS. *Allis-Chalmers Mfg. Co., Milwaukee 1, Wis.* Design and construction features of Allis-Chalmers automatic reduced voltage starters from 50 to 1200 hp, 600 volts, are described in Bulletin 14B8192. Included is motor control engineered for centrifugal compressors, hammer mills, pumps, large conveyors, large fans, motor-generator sets, and other applications.

Index to Advertisers

ACF Industries Inc., 22

Atlas Powder Co., 15

Bethlehem Steel Co., 26, 51

Bowdil Company 93

Bucyrus-Erie Co., 78

Card Iron Works, Inc., C. S., 90

Cardox Corp., 5

Caterpillar Tractor Co., 73

Chicago Pneumatic Tool Co., 8

Colorado Fuel & Iron Corp., The, 14

Deister Concentrator Co., The, 81

Denver Equipment Co., Inside Front Cover

Euclid Division, 18
General Motors Corp.

General Cable Corp., 27

Gerow, Theron G., 82

Hardinge Company, 84

Hendrick Mfg. Co., 70

Heyl & Patterson, Inc., 71

International Harvester Co., 47-48-49-50

Jeffrey Mfg. Co., 83

Joy Mfg. Co., 16-17

Kennametal Inc., 28

Lee-Norse Co., 19

Leroi Div., 88
Westinghouse Air Brake Co.

LeTourneau-Westinghouse Co., 7, 9, 11, 13

Longyear Co., E. J., 82

Mack Trucks, Inc., 24

Mine Safety Appliances Co., Back Cover

National Electric Coil Co., Inside Back Cover

National Mine Service Co., 25

Nordberg Mfg. Co., 12

Pattin Mfg. Co., 87

Read, Davis, 82

Sanford-Day Iron Works, Inc., 2-3

Sheffield Steel, 23
Division Armco Steel Corp.

Sprague & Henwood Inc., 82

Texas Gulf Sulphur Co., 6

Timken Roller Bearing Co., 80

Union Wire Rope Corp., 20-21

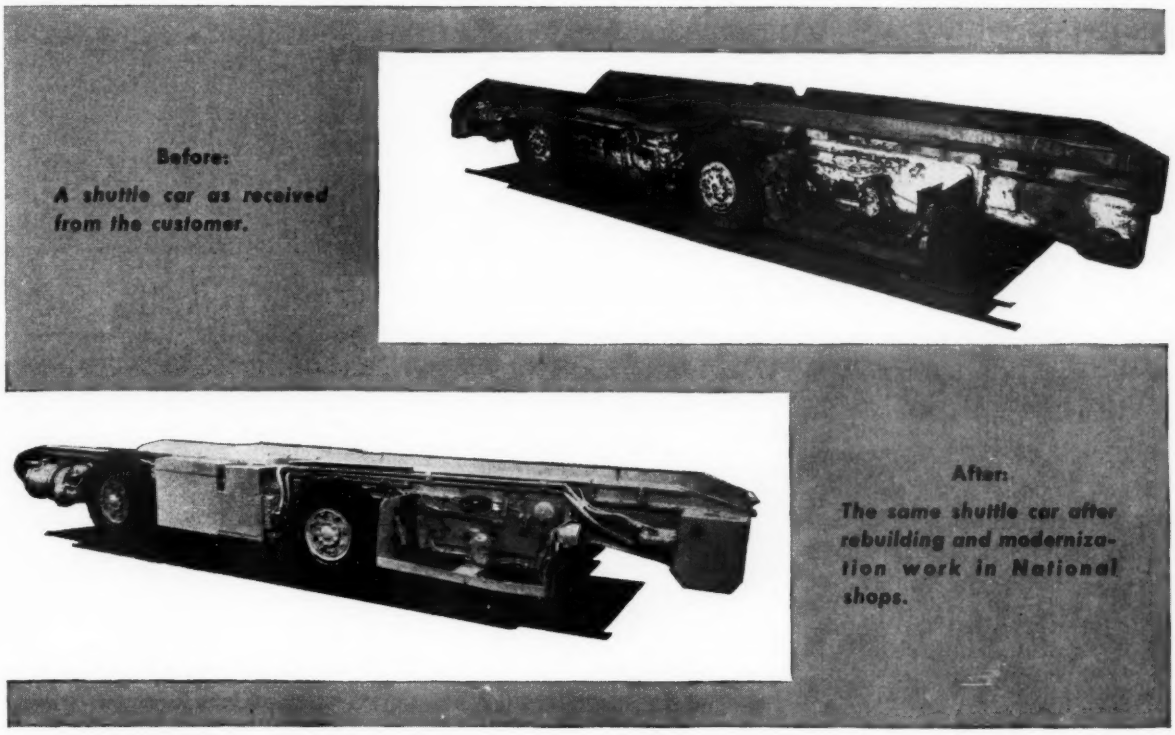
United States Rubber Co., 4

U. S. Steel Corp., 10
American Steel & Wire Div.
Columbia-Geneva Steel Div.
Tennessee Coal & Iron Div.
United States Steel Export Div.

Vulcan Iron Works, 91

Western Machinery Company, 86

Woomer, J. W. & Associates, 82



Before:
A shuttle car as received from the customer.

After:
The same shuttle car after rebuilding and modernization work in National shops.

here's how NATIONAL breathes new life into your old mining machines

- **all units are completely dismantled and every part carefully inspected**
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Built-in → quality here

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